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Environmental
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FINAL REPORT
Volume 2 of 4

Project Summary Report for Pilot-Scale Demonstration of Red Water Treatment by Wet Air Oxidation and Circulating Bed Combustion

October 1995
Contract No. DACA31-91-D-0074
Task Order No. 0005

Prepared by:

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Prepared for:

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Aberdeen Proving Ground, MD 21010-5401

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FINAL

PROJECT SUMMARY REPORT

FOR

PILOT SCALE DEMONSTRATION OF
RED WATER TREATMENT BY WET AIR OXIDATION
AND CIRCULATING BED COMBUSTION

VOLUME 2 OF 4

USAEC Contract No. DACA 31-91-D-0074
Task Order No. 5

Prepared by

IT Corporation
Cincinnati, Ohio

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Preface

As part of the U.S. Army's ongoing program related to the research and development of red water treatment technologies, the U.S. Army Environmental Center (USAEC) contracted IT Corporation to prepare conceptual designs and plans for pilot-scale demonstrations of two treatment technologies: wet air oxidation (WAO) and circulating bed combustion (CBC). The project objectives also included development of a Test Plan and Health and Safety Plan for these demonstrations, and preparation of a Project Report. This Project Report is intended to summarize the conceptual designs, Test Plan, and Health and Safety Plan and to serve as a guide for activities when the next phase of this program (i.e., conducting the demonstrations) is implemented.

Red water is not currently generated by the U.S. Army or any other part of the U.S. Department of Defense nor has it been generated in the recent past. An accurate and complete database does not exist in regard to the chemical and physical nature of red water. Due to this lack of waste characterization data, it was not possible to complete an accurate analysis of the associated testing and treatment requirements. Additionally, the source of red water for testing and the location where the tests will be conducted (i.e., the host facility) have not been identified. Therefore, waste- and site-specific concerns and requirements cannot be accurately or completely addressed at this time. As a result, this phase of the investigation included completion of plans and conceptual designs. Completion of system designs and finalization of test and safety plans must be completed in the future prior to initiation of the demonstration program.

This Project Report outlines the current project status and identifies the steps which must be completed prior to conducting the demonstrations. These include: selecting a host facility, obtaining red water for the demonstrations, characterizing the red water, preparing final process and equipment designs, finalizing Health and Safety and Test Plans, and acquiring the test equipment. Because of the unique and largely undocumented nature of red water, once a source has been identified, a critical initial objective will be characterization of the physical and chemical nature of the waste and a review of the associated treatment requirements.

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Appendix D - Wet Air Oxidation Vendor Summary

Appendix E - Wet Air Oxidation Treatability Study Report

Appendix F - Circulating Bed Combustion Treatability Study Report

Appendix A is in Volume 1; Appendix B is in Volume 2; Appendix C is in Volume 3; and Appendices D, E, and F are in Volume 4.

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APPENDIX B

WET AIR OXIDATION CONCEPTUAL DESIGN REPORT (Prepared by Kenox Corporation)

KENOX CORPORATION

**WET AIR OXIDATION PILOT
PLANT**

FOR

RED WATER

CONCEPTUAL DESIGN REPORT

Prepared For:

***IT CORPORATION
Cincinnati, Ohio***

***Kenox Project No. UJ41014
Purchase Order No. 483392***

December 1994

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SECTION 1.0.

GENERAL DESCRIPTION

1.0. GENERAL DESCRIPTION

1.1. INTRODUCTION

Red water is the waste water generated from the purification stage of the manufacturing process of 2,4,6-trinitrotoluene (TNT). During the purification stage, a sellite solution is added to the crude TNT to remove unsymmetrical isomers. The red water generated contains dinitrotoluene (DNT) sulfonated compounds and products of incomplete nitration of toluene to TNT (i.e. priority pollutants 2,4-DNT and 2,6-DNT).

Red water is currently classified by the EPA as an RCRA-regulated reactive hazardous waste (KO47). The feasibility of using Wet Air Oxidation (WAO) for the treatment of TNT red water was confirmed by the study which was performed by the Department of Civil Engineering at the University of Maryland, under contract with the U.S. Army Construction Engineering Research Laboratory. As a result, the U.S. Army Environmental Center (USAEC) has decided to investigate a piloting program to treat TNT red water in a Wet Air Oxidation system.

This document is prepared as part of the task entitled "Red Water Treatment Technology Test Plan and Site Preparation" for the USAEC. The objectives of this task are to prepare test and safety plans, determine the best conceptual designs, and prepare layouts for pilot scale Circulating Bed Combustors (CBCs) and WAO treatment systems. Due to the uncertainty of the pilot plant demonstration location, the units are designed to be transportable.

This design package presents the conceptual design, layout and cost estimate of a mobile Kenox Wet Air Oxidation pilot plant. Further process engineering and detailed design engineering is necessary prior to construction of the Kenox pilot plant.

The Kenox WAO system presented here is a transportable pilot plant consisting of a feed preparation and preheat section, reaction section and separation and pressure let down section. The red water is diluted and preheated in the feed preparation section and then mixed with air prior to entering the reaction section. The reactor system operates at 484 deg F and 1000 psia. Spent air and oxidized waste leaving the reactor system are cooled and fed into a two stage pressure let down and separation system prior to being discharged from the WAO system.

This design package contains the following major sections:

- **1.0 General Description** - Presents a brief introduction to the project and contents, the WAO design basis and a WAO block diagram.
- **2.0 Process Description** - Presents a process overview of the Kenox WAO system and a description of each key system section.

- **3.0 PFD and P&IDs Package** - Presents the Process Flow Diagram (PFD) and the Piping and Instrumentation Diagrams (P & IDs) for the WAO system.
- **4.0 Equipment List** - Presents a table of the key equipment components.
- **5.0 Equipment Specifications** - Presents the process specification sheets for each key WAO component.
- **6.0 Utility Consumption** - Presents the utility consumptions of the WAO system.
- **7.0 General Arrangement Drawings** - Presents the general arrangement plans for the WAO system.
- **8.0 Electrical One-Line Drawing** - Presents the electrical one-line drawing for the WAO system.
- **9.0 Mass & Energy Balance Outputs** - Presents the basis and results of mass and energy balances conducted for normal operations.
- **10.0 Pilot Plant Cost Estimate** - Presents the cost estimates for purchase and lease of Kenox WAO equipment.
- **11.0 Treatability Study** - Presents the autoclave procedures and results.
- **12.0 Operations & Safety Considerations** - Presents the health and safety considerations of the WAO operations.
- **13.0 Sampling Plan** - Presents the general process and emissions sampling procedures.
- **14.0 Operations Manual** - Presents a draft Kenox WAO operations manual.

1.2. DESIGN BASIS

In preparing this conceptual design, Kenox has relied to a significant extent on the experimental data, observations and results presented in the Phull (1992) and Hao (1993) reports and Kenox' preliminary treatability study on the TNT red water. Additional assumptions and considerations were also made in the absence of data. These assumptions and the literature review results require confirmation through an extended treatability study before the design of the system is to be finalized. The initial conceptual design basis and considerations are discussed below.

1.2.1. Red Water Characteristics

The manufacturing process of 2,4,6-trinitrotoluene (TNT) consists of two stages: (i) nitration of toluene to crude TNT and (ii) sellite purification to remove the unsymmetrical TNT isomers and other impurities. During the purification stage, the sodium sulfite (sellite) that is added to crude TNT, reacts selectively with the unsymmetrical TNT isomers to produce dinitrotoluene (DNT) sulfonated compounds. The waste water which is generated during this stage (also known as red water) contains the dinitrotoluene sulfonated compounds, products of incomplete nitration of toluene to TNT from the first stage and other complex byproducts formed during the nitration and purification stages.

Based on Radford Army Ammunitions Plant data on red water characteristics (forwarded by IT Corporation to Kenox, see Tables 1.1 and 1.2), red water in general has a COD range of 65,000 mg/l to 120,000 mg/l, a pH of 7.0 to 9.7 and contains 15 to 30 percent solids. Inorganic salts make up 45 wt% of the solids and nitro bodies make up the remaining 55 wt%.

This conceptual design assumes that dinitrotoluene sulfonated (DNTS) compounds constitute the major COD contributor in red water. Due to limited physical data available on DNTS, the mass and energy balance assumed the following sequence of reaction pathways: (1) removal of the sulfonic group from DNTS to form dinitrotoluene and sulfuric acid; and (2) oxidation of dinitrotoluene with air to produce carbon dioxide, water and nitrogen.

1.2.2. Dilution of Feed

The selection of the design pressure of the reactor system will have to take into account the overpressurization of the system in the event of an uncontrollable reaction. Kenox' preliminary evaluation indicated that the optimum system design pressure can be achieved at a feed concentration of 6 % COD.

1.2.3. Design Conversion Levels and Feed Rates

The Kenox pilot plant is designed to treat 1.5 USGPM of raw red water at a COD level of 120,000 mg/l. The incoming red water will be diluted to a COD level of 60,000 mg/l with a treated effluent recycle stream due to safety concerns and excessive evaporation in the Kenox reactors with the high incoming COD level. The design throughput after dilution of the feed stream is 3.0 USGPM. Experimental data reported in Phull's dissertation (1992), predict a COD conversion in the 85% range at WAO reaction conditions of 485 deg F .

1.2.4. pH Adjustment

Initial pH of the waste feed stream can have a significant impact on the performance of the oxidation reaction. In this Kenox design, a feed pH of 5 is required.

1.2.5. Definitions of Kenox Inside Battery Limits

The Kenox inside battery limits are defined as follows:

- Inlet of the Kenox unit: Feed to the suction of the waste feed pump, P-101.
- Outlet of the Kenox unit: Effluent from the discharge of the final effluent pump, P-105.
- Refer to the attached PFD in Section 3.0 for details on the definitions of Kenox inside battery limits.

1.2.6. Design Inlet Battery Limit Conditions

Raw Feed Flow, USGPM	1.5
pH	7.0 - 9.7
COD, mg/l (min/max)	65,000/120,000
Temperature, deg F	60
Compositions	see Tables 1.1 & 1.2

1.2.7. Design Outlet Battery Limit Conditions

pH	2.0 - 4.0
Temperature, deg F	107
Pressure, psia	50
COD, conversion	85%

1.2.8. Material of Construction

As reported in Phull's dissertation, the corrosivity of red water is aggravated under process conditions of high temperature, high pressures and low pH of oxidized solutions. Sulfonated nitroaromatics are expected to be more corrosive when subjected to WAO due to the formation of inorganic salts. On the basis of the corrosion testing performed by Phull, titanium is selected as the material of construction for Kenox reactors and associated equipment and piping when the process temperature exceeds 100 °F. For process effluent temperatures less than 100 °F, equipment and piping will be constructed from 316 stainless steel. pH adjustment on the rundown effluent from the Kenox unit, if required is not included in the design scope.

1.2.9. Plot Area

Due to the uncertainty of the pilot plant demonstration location, the unit is designed to be transportable and to be operable indoors or outdoors. The required minimum plot space for this Kenox unit is approximately 16' x 48'.

1.2.10. Service Factor

It is anticipated that the service factor for the Kenox system will be in the order of 90 %. Rotating equipment spare parts inventories are at the client's choice and judgment between the penalty for short term shutdown versus the cost of the spare equipment. However, Kenox recommends that spare parts for critical and long term delivery items be stored. A list of spare parts will be provided upon the completion of detailed engineering.

Table 1.1 Red Water Characteristics

Chemical Oxygen Demand, mg/L	65,000 - 120,000
Total Solids, %	15 - 30
Specific Gravity	1.1
Nominal Solids Heat Value	3,200 BTU/lb
Suspended Solids, mg/L	32
pH	7.0 - 9.7
Soluble Chloride, mg/L	70
Total Kjeldahl Nitrogen, mg/L	11,129
Nitrate Nitrogen, mg/L	1,739
Nitrite Nitrogen, mg/L	6,788
Ammonia Nitrogen, mg/L	150
Metals, mg/L	
Calcium	39 - 346
Iron	4.9 - 307
Magnesium	25 - 90
Potassium	42
Aluminum	2.1 - 10
Chromium	0.14 - 4.9
Barium	0.22 - 3.0
Copper	2.3
Cadmium	0.7
Silver	0.4
Zinc	6.4

Reference: Radford Army Ammunitions Plant, 1988, "Review of Canadian Industries Limited's Boloeil Facility as a Candidate for a SRP Pilot Test."

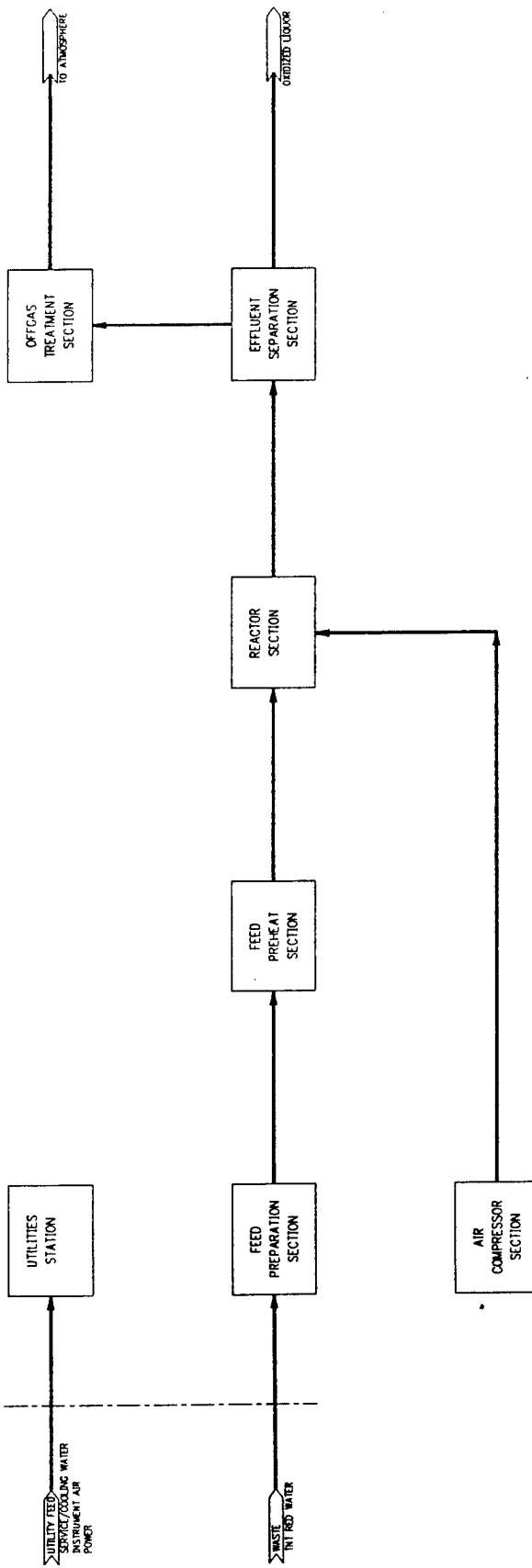
Table 1.2 Composition of Red Water Solids

Inorganic Salts, wt%	
Na ₂ SO ₃ -Na ₂ SO ₄	32.3
NaNO ₂ (sodium nitrite)	11.2
NaNO ₃ (sodium nitrate)	1.5
NAHS-Na ₂ S (sodium sulfide)	may be present
Sodium bicarbonate/carbonate	may be present
Subtotal Inorganic Salts, wt%	45
Nitrobodyes, wt%	
Sodium sulfonate of 2,4,5 TNT	22.7
alpha - TNT - Sellite complex	16.2
Sodium sulfonate of 2,3,4 TNT	9.6
Sodium sulfonate of 2,3,5 TNT	2
Sodium sulfonate of 2,3,6 TNT	trace
2,4,6-TNBA (trinitrobenzoic acid) Na salt	1.0
White compound sodium salt *	1.0
TNBAL - bisulfite addition compound	1.0
(trinitrobenzaldehyde)	
TNBOH (trinitrobenzyl alcohol)	1.0
Sodium nitroformate	0.5
3,4 - DNBA (dinitrobenzoic acid) Na salt	trace
2,3 - DNBA (dinitrobenzoic acid) Na salt	trace
TNB (trinitrobenzene) - Sellite complex	trace
Dissolved 2,4-DNT (dinitrotoluene)	trace
Dissolved alpha - TNT (trinitrotoluene)	trace
Subtotal Nitrobodyes, wt%	55

* "White compound" is believed to be 2,2-dicarboxy-3,3"5,5"-tetranitroazoxybenzene

Reference: Radford Army Ammunitions Plant, 1988, "Review of Canadian Industries Limited's Boloeil Facility as a Candidate for a SRP Pilot Test".

BATTERY LIMIT
CLIENT KENOX



KENOX CORPORATION

BLOCK FLOW DIAGRAM USAEC RED WATER TREATMENT TECHNOLOGY TEST PLAN AND SITE PREPARATION PROJECT

DESIGNED BY B. MULL	DESIGNED BY B. MULL	DESIGNED BY T. LIT
DATE NONE	DATE DEC. / 1984	DATE TDL
PROJECT NO. 941014	PROJECT NO. 941014-BD-130	PROJECT NO. 0

CAD FILE: 1701010.DWG

SECTION 2.0.

PROCESS DESCRIPTION

2.0. PROCESS DESCRIPTION

The following process description refers to equipment shown on the PFD and P&IDs in Section 3.

2.1. FEED PREPARATION & PREHEAT

To prevent excessive evaporation in the Kenox reaction section, the maximum COD concentration for TNT red water to be processed in this WAO system is 6%. For TNT red water containing COD level above 6%, feed dilution is required before being introduced to the Kenox reactor. TNT red water from storage outside Kenox' battery limits is pumped at a rate of 1.5 USGPM by waste feed pump, P-101, to the feed drum, D-104. At the inlet of this drum, the waste is mixed with a treated Kenox effluent recycle stream which is delivered by the final effluent pump P-105, or service water via dilution feed pump P-102 to maintain the maximum COD in the feed at 6%. This blending is performed by the flow ratio controller, FFRC-401.

The diluted feed is pumped from the feed drum by high pressure feed pump, P-103 to the inlet tubeside of feed/effluent exchanger, E-101 where it is preheated by the reactor system's effluents to the required inlet temperature to the Kenox reactor section. During start up, the electric heater E-102 will be used to heat the feed up to the desired reaction temperature.

2.2. REACTION & SEPARATION SECTIONS

The Kenox reaction section comprises of reactors connected in series. Compressed air is injected into the reactors to supply the required oxygen for the reaction. Reactor effluent is cooled to 104 deg F via the feed/effluent exchanger E-101 and the water cooler, E-103. Spent air and oxidized waste water leave the cooler and proceed to a two stage pressure let down and separation system, D-101 and D-102.

The off-gas, which at this point is mainly carbon dioxide, nitrogen and water vapor is vented to the atmosphere. The oxidized waste water is sent to the effluent drum, D-105. From the outlet of D-105, part of the oxidized waste water is recycled back via the effluent recycle pump, P-105 to the discharge of the feed waste pump, P-101. The other portion is pumped to the client's storage outside Kenox' battery limits.

2.3. COMPRESSED AIR

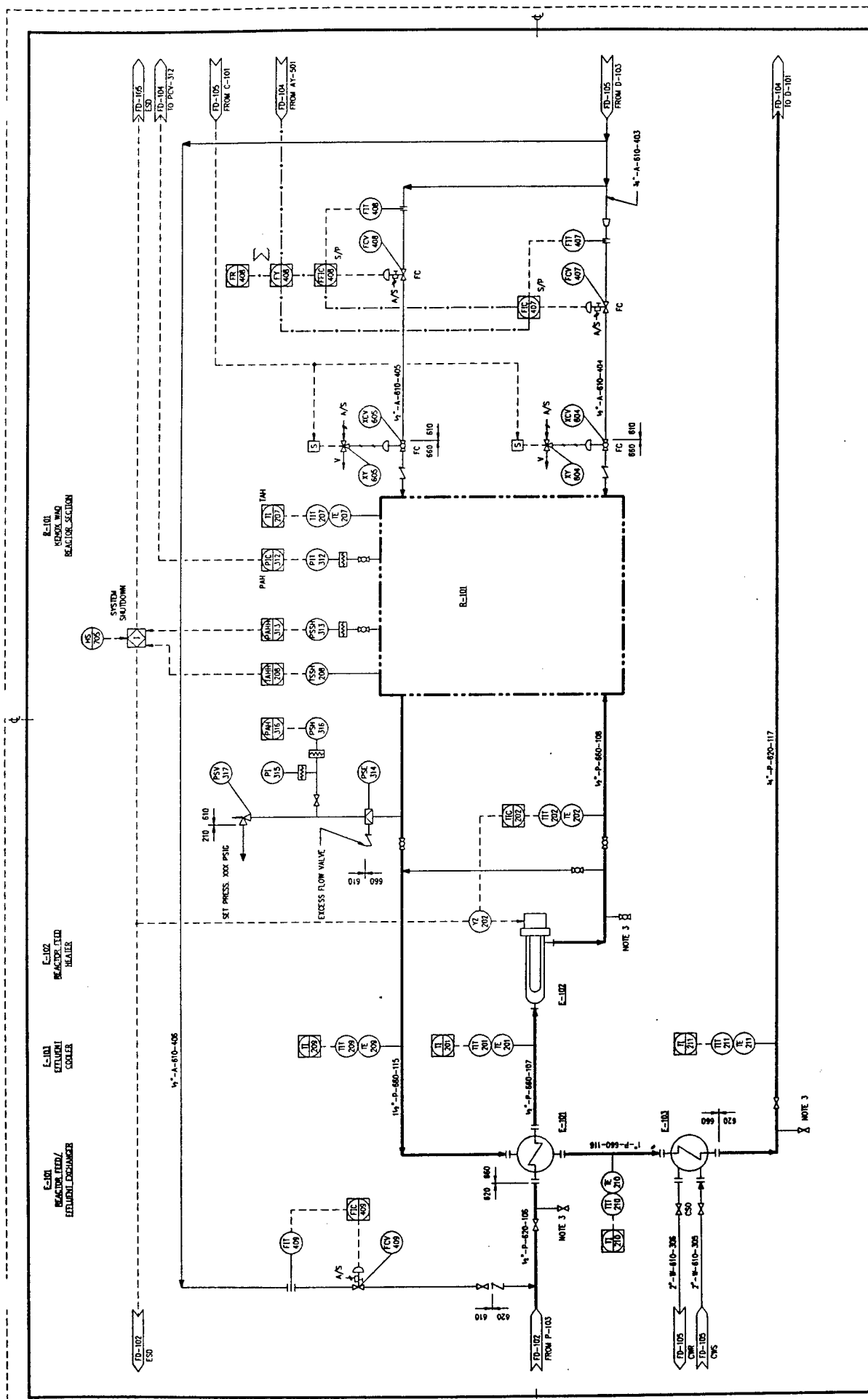
Air is supplied to the Kenox reactors by the reciprocating compressor, C-101. Compressed air leaving the compressor at 1050 psia flows to the air accumulator D-103. The total air flow to the Kenox reactors is controlled by an oxygen analyzer which measures the O₂ content of the offgas leaving the system.

SECTION 3.0.

PFD AND P&IDs PACKAGE

DRAWING INDEX

[illegible]



NOTES:

- HIGH POINT VENTS, LOW POINT DRAINS TO BE INCLUDED
- DRAIN & SAMPLE POINT CONNECTION
- FLUSH CONNECTION

LINE IDENTIFICATION

LINE SIZE: 1" - 24" - 30"

SERVICE: STEAM, WATER, GAS, OIL

MATERIAL CLASS: 1 - CS, 2 - SS, 3 - INCONEL, 4 - PHC, 5 - ALLOY C-276, 6 - TITANIUM

FIELD INSTRUMENT

FO: FAN OPEN, FOC: FAN CLOSE, FAL: FAN LAST POSITION, FV: FAN VIBRATION, FV: FAN VIBRATION, FV: FAN VIBRATION

FIELD INSTRUMENT: CONTROL PANEL, FRONT / REAR, CONTROL SYSTEM, VISIBLE / NON-VISIBLE

INSTRUMENT LEGEND

FO: FAN OPEN, FOC: FAN CLOSE, FAL: FAN LAST POSITION, FV: FAN VIBRATION, FV: FAN VIBRATION, FV: FAN VIBRATION

FIELD INSTRUMENT: CONTROL PANEL, FRONT / REAR, CONTROL SYSTEM, VISIBLE / NON-VISIBLE

SERVICE FLUID

A - AIR, C - CHEMICALS, P - PROCESS, S - STEAM & COND., W - WATER, L - LIQUID, G - GAS, O - OIL

MATERIAL CLASS

1 - CS, 2 - SS, 3 - INCONEL, 4 - PHC, 5 - ALLOY C-276, 6 - TITANIUM

LINE IDENTIFICATION

LINE SIZE: 1" - 24" - 30"

SERVICE: STEAM, WATER, GAS, OIL

MATERIAL CLASS: 1 - CS, 2 - SS, 3 - INCONEL, 4 - PHC, 5 - ALLOY C-276, 6 - TITANIUM

INSTRUMENT LEGEND

FO: FAN OPEN, FOC: FAN CLOSE, FAL: FAN LAST POSITION, FV: FAN VIBRATION, FV: FAN VIBRATION, FV: FAN VIBRATION

FIELD INSTRUMENT: CONTROL PANEL, FRONT / REAR, CONTROL SYSTEM, VISIBLE / NON-VISIBLE

SERVICE FLUID

A - AIR, C - CHEMICALS, P - PROCESS, S - STEAM & COND., W - WATER, L - LIQUID, G - GAS, O - OIL

MATERIAL CLASS

1 - CS, 2 - SS, 3 - INCONEL, 4 - PHC, 5 - ALLOY C-276, 6 - TITANIUM

KENOX CORPORATION

PIPING & INSTRUMENTATION DIAGRAM

WAO PREHEAT & REACTOR SECTIONS

USAREC RED WATER TREATMENT TECHNOLOGY

TEST PLAN AND SITE PREPARATION PROJECT

Drawn by: B. WELLS, Date: DEC / 1994, Scale: 1" = 10'

Checked by: J. L. LEE, Date: DEC / 1994, Scale: 1" = 10'

Project No: 941014, Drawing No: FD-103, Revision: C

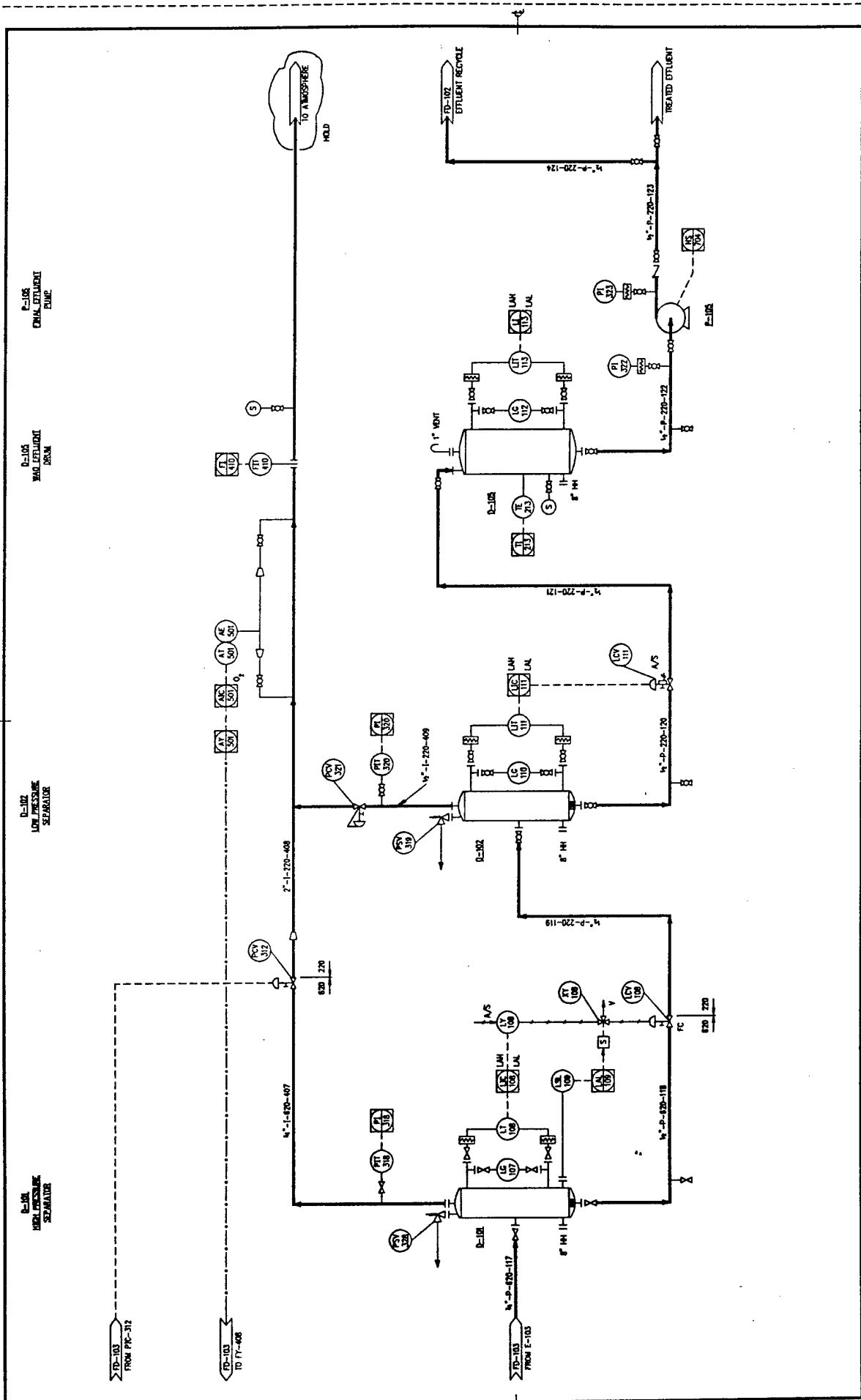
NO.	DATE	BY	CHKD.	DESCRIPTION
1	DEC / 1994	B. WELLS	J. L. LEE	PRELIMINARY
2	DEC / 1994	B. WELLS	J. L. LEE	REVISED TO ADD P-276 & L-276 TO P-276 & L-276
3	DEC / 1994	B. WELLS	J. L. LEE	REVISED TO ADD P-276 & L-276 TO P-276 & L-276

USAREC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

Drawn by: B. WELLS, Date: DEC / 1994, Scale: 1" = 10'

Checked by: J. L. LEE, Date: DEC / 1994, Scale: 1" = 10'

Project No: 941014, Drawing No: FD-103, Revision: C



NOTES:

- HIGH POINT SPTS, LOW POINT DRAINS TO BE INCLUDED

LINE IDENTIFICATION

LINE SIZE: 1" - 2" - 220 - 010

SERVICE: AIR, PROCESS, STEAM & COND., WATER, INERT GAS, OR

MATERIAL CLASS: 1 - 125 PSIG, 2 - 150 PSIG, 3 - 300 PSIG, 4 - 600 PSIG

MATERIAL: 1 - C.S., 2 - S.S., 3 - INCONEL, 4 - TITANIUM, 5 - ALLOY C-276, 6 - TITANIUM

INSTRUMENT LEGEND

FIELD INSTRUMENT: CONTROL PANEL, FRONT / REAR, CONTROL SYSTEM, VISIBLE / NON-VISIBLE

FUNCTION: FAIL OPEN, FAIL CLOSE, FAIL LAST POSITION, PNEUMATIC SIGNAL, ELECTRIC SIGNAL, HARD WIRE INTERLOCK, SOFTWARE SIGNAL

SERVICE ELIER

A - AIR, C - CHEMICALS, P - PROCESS, S - STEAM & COND., W - WATER, I - INERT GAS, L - OR

MATERIAL CLASS

220: 1 - 125 PSIG, 2 - 150 PSIG, 3 - 300 PSIG, 4 - 600 PSIG

MATERIAL: 1 - C.S., 2 - S.S., 3 - INCONEL, 4 - TITANIUM, 5 - ALLOY C-276, 6 - TITANIUM

941014

941014-FD-104

C

KENOX CORPORATION

PIPING & INSTRUMENTATION DIAGRAM

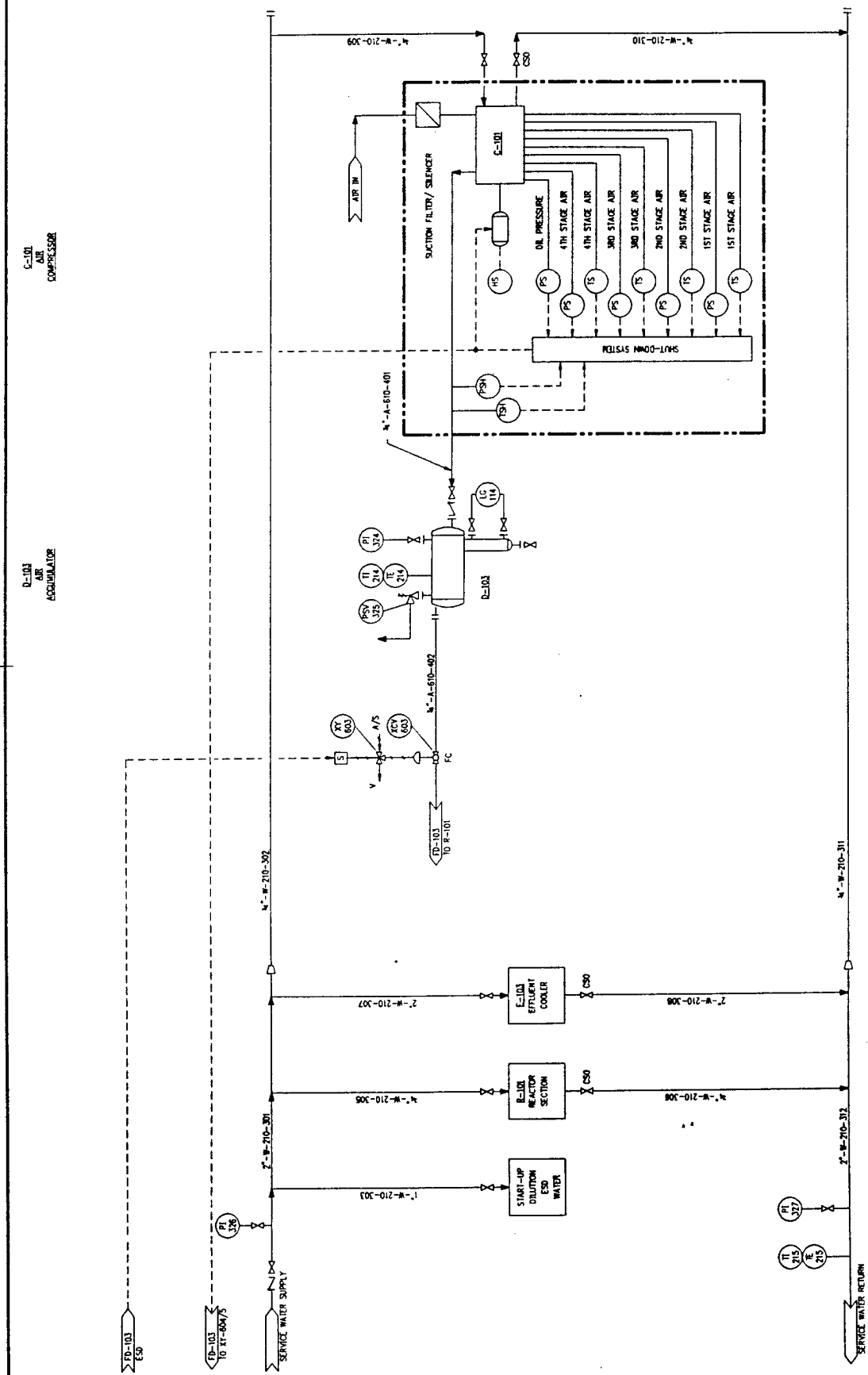
EFFLUENT SEPARATION SECTION

USAFEC RED WATER TREATMENT TECHNOLOGY

TEST PLAN AND SITE PREPARATION PROJECT

REVISIONS

NO.	DATE	DESCRIPTION	BY	CHKD
1	11/11/94	ISSUED FOR CONSTRUCTION	J. L. L.	J. L. L.



NOTES:

- HIGH POINT MOUNTS, LOW POINT DRAINS TO BE INCLUDED

LINE IDENTIFICATION

LINE SIZE: 1" - 2" - 220 - 210

SERVICE CLASS: C - CHEMICALS, P - PROCESS, S - STEAM & COND., W - WATER, I - INERT GAS, L - OIL

MATERIAL CLASS: 1 - CS, 2 - 125 PSIG, 3 - 150 PSIG, 4 - 200 PSIG, 5 - 300 PSIG, 6 - 600 PSIG

MATERIAL: 1 - CS, 2 - 304 SS, 3 - 316 SS, 4 - 321 SS, 5 - ALLOY C-276, 6 - TITANIUM

INSTRUMENT LEGEND

FIELD INSTRUMENT: ○ (Pressure), ⊖ (Flow), ⊕ (Temperature), ⊙ (Level), ⊔ (Vibration), ⊕ (pH), ⊖ (ORP), ⊕ (DO), ⊖ (RTD), ⊕ (PTD), ⊖ (FTD), ⊕ (FID), ⊖ (TID), ⊕ (LID), ⊖ (PID), ⊕ (TID), ⊖ (LID), ⊕ (PID)

CONTROL PANEL: ⊖ (Flow), ⊕ (Temperature), ⊙ (Level), ⊔ (Vibration), ⊕ (pH), ⊖ (ORP), ⊕ (DO), ⊖ (RTD), ⊕ (PTD), ⊖ (FTD), ⊕ (FID), ⊖ (TID), ⊕ (LID), ⊖ (PID), ⊕ (TID), ⊖ (LID), ⊕ (PID)

CONTROL SYSTEM: ⊖ (Flow), ⊕ (Temperature), ⊙ (Level), ⊔ (Vibration), ⊕ (pH), ⊖ (ORP), ⊕ (DO), ⊖ (RTD), ⊕ (PTD), ⊖ (FTD), ⊕ (FID), ⊖ (TID), ⊕ (LID), ⊖ (PID), ⊕ (TID), ⊖ (LID), ⊕ (PID)

FIELD INSTRUMENT: ⊖ (Flow), ⊕ (Temperature), ⊙ (Level), ⊔ (Vibration), ⊕ (pH), ⊖ (ORP), ⊕ (DO), ⊖ (RTD), ⊕ (PTD), ⊖ (FTD), ⊕ (FID), ⊖ (TID), ⊕ (LID), ⊖ (PID), ⊕ (TID), ⊖ (LID), ⊕ (PID)

UTILITY FLOW DIAGRAM

USAEC RED WATER TREATMENT TECHNOLOGY TEST PLAN AND SITE PREPARATION PROJECT

DESIGNED BY: B. HOLL, DATE: DEC. / 1994, SCALE: 1" = 10' (VERTICAL), 1" = 10' (HORIZONTAL)

APPROVED BY: J. LEE, DATE: DEC. / 1994, SCALE: 1" = 10' (VERTICAL), 1" = 10' (HORIZONTAL)

PROJECT NO.: 941014, DRAWING NO.: 941014-FD-105, C

KENOX CORPORATION

10000 KENOX DRIVE, SUITE 100, KENOX, ALABAMA 35891-1000

TEL: (205) 833-1000, FAX: (205) 833-1001

WWW.KENOX.COM

SECTION 4.0.

EQUIPMENT LIST

CLIENT: IT CORPORATION

PROJECT: USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

ISSUE	DATE	CHKD.	APPR.	DESCRIPTION
0	NOV 30/94	BM	BAW	CONCEPTUAL DESIGN

TAG NO.	EQUIPMENT NAME	UNIT WEIGHT (LB.)	CAPACITY (SCFM)	DISCHARGE PRES.(PSIA)	MOTOR HP RPM	TYPE	MATERIAL	C.W. (USGPM)	POWER (KW)	REMARKS
C-101	AIR COMPRESSOR	7000	112	1050	100	4 STG. RECIP.	C.S.	12	60	
		WT. EMPTY (LB.)	SIZE I.D. X T/T	DESIGN PRES.(PSIA)	DESIGN TEMP. (°F)	INSULATION TYPE THK (IN.)	MATERIAL			
D-101	HIGH PRESSURE SEPARATOR	550	13" 4'-0"	1070	155	PP	316 S.S.	-	-	
D-102	LOW PRESSURE SEPARATOR	340	13" 4'-0"	75	160	PP	316 S.S.	-	-	
D-103	AIR ACCUMULATOR	600	14" 4'-0"	1160	310	HC	C.S.	-	-	
D-104	FEED DRUM	1250	40" 6'-0"	30	135	N	316 S.S.	-	-	
D-105	WAO EFFLUENT DRUM	1250	40" 6'-0"	30	160	N	316 S.S.	-	-	
		SURFACE AREA(SQ. FT.)	DUTY (K BTU/HR)	DESIGN PRES. SHELL TUBES	DESIGN TEMP. SHELL TUBES	INSULATION TYPE THK (IN.)	MATERIAL SHELL TUBES			
E-101	REACTOR FEED EFFLUENT EXCH.	24	431	1090 1160	535 415	HC	TI	-	-	DOUBLE PIPE
E-102	REACTOR FEED HEATER	-	324	N/A 1160	N/A 530	HC	N/A	-	95	ELECTRIC HEATER
E-103	EFFLUENT COOLER	36	589	720 1080	140 455	PP	CS	68	-	DOUBLE PIPE
		UNIT WEIGHT	NORMAL FLOW RATE (USGPM)	PRES. (PSIA) DISCH. DIFF.	MOTOR HP RPM	TYPE	MATERIAL WETTED PARTS			
P-101	WASTE FEED PUMP	75	1.5	48 30	0.75 3450	CENTRIFUGAL	316 S.S.	-	0.5	
P-102	DILUTION FEED PUMP	75	1.5	48 30	0.75 3450	CENTRIFUGAL	316 S.S.	-	0.5	
P-103	HIGH PRESSURE FEED PUMP	90	3	1050 1030	3 600	POSITIVE DISPL.	316 S.S.	-	1.6	DIAPHRAGM
P-105	FINAL EFFLUENT PUMP	75	3	53 35	1 3450	CENTRIFUGAL	316 S.S.	-	0.75	
		WT. EMPTY (LB.)	SIZE I.D. X T/T	DESIGN PRES.(PSIG)	DESIGN TEMP. (°F)	INSULATION TYPE THK (IN.)	MATERIAL			
R-101	REACTOR SECTION	6200		1100	535	HC	TITANIUM	15	4	

LEGEND: INSULATION - HC - HEAT CONSERVATION
 PP - PERSONNEL PROTECTION
 AS - ANTI-SWEAT
 N - BARE

SECTION 5.0.

EQUIPMENT SPECIFICATIONS

COMPRESSOR DATA SHEET

Equipment Name **Air Compressor**

Total Number Required **One**

DESIGN CONDITIONS		C-101	
Gas Handled		Air	
Std. Capacity	SCFM	112	
Weight Flow	lb/hr	510	
Critical Pressure	psia	547	
Critical Temperature	deg F	-221	
Relative Humidity			
Molecular Weight		28.8	

Inlet			
Pressure	psia	14.7	
Temperature	deg F	Ambient	
Cp/Cv		1.4	
Compressibility		1	
Inlet Volume	ACFM	113	

Outlet			
Pressure	psia	1050	
Temperature	deg F		
Cp/Cv			
Compressibility			
Discharge Volume	CFM		

Miscellaneous			
Adiabatic	kW		
BHP	kW		
Speed	rpm		

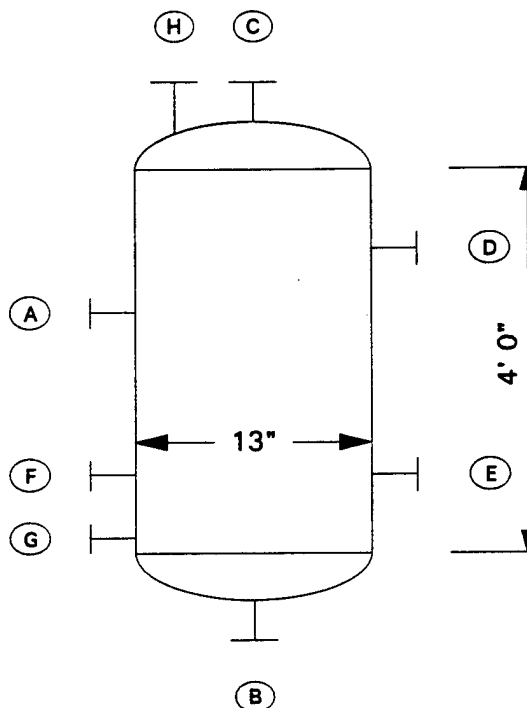
Compressor Connections (1)		Motor	
Suction Size	in., Rating	Motor hp	
Discharge Size	in., Rating	Volts 460 Phase 3 Hertz 60	
Cooling Water		Electrical Classification Class I & II, Div. 1	
Inlet Temp.	68 deg F	Materials	
Differential Temperature	18 deg F	Casing	
Max. Allowable Pressure Drop	psi	Piston	
		Shaft	

Remarks:

1. Compressor vendor to confirm and supply all applicable information to fully complete data sheet.
2. Cooling is not required for final stage.
3. Compressor vendor to supply:
 - (i) Suction air filters and silencers
 - (ii) Pressure relief valves.
 - (iii) Local temperature and pressure gauges for all stages
 - (iv) Shutdown protection switches
 - (v) Compressor control system to be mounted in appropriate enclosure.
 - (vi) Motor starter with enclosure.

PROJECT: IT Corporation - TNT Redwater						KENOX		PROJECT NO. UJ41014		DIVISION NO. 	
						CLIENT: IT Corporation		EQUIPMENT NO. C-101		REV. 0	
						LOCATION:		SHEET		1 OF 1	
NO.	DATE	REVISION	BY	CHK.	APP.						
0	11/22/94	For Quotation	BM		<i>RW</i>						

VERTICAL VESSEL DATA SHEET

[illegible]

Remarks:

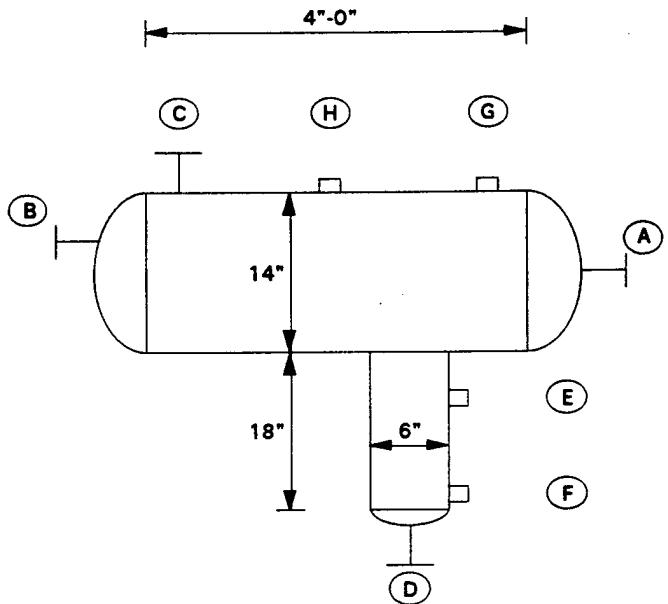
1. Vortex breaker at liquid outlet to be provided.
2. Ellipsoidal heads.
3. Final complete data sheet subjected to Kenox approval.

PROJECT:						KENOX	PROJECT NO.		DIVISION NO.	
IT Corporation - TNT Red Water							UJ41014			
							EQUIPMENT NO.		REV.	
1	12/21/84	NOZZLE 'H' ADDED	BM			CLIENT: IT Corporation	D-101		1	
0	11/18/84	For Quotation	BM							
NO.	DATE	REVISION	BY	CHK.	APP.	LOCATION:	SHEET		1 OF 1	

[illegible]

HORIZONTAL VESSEL DATA SHEET

Equipment Name: Air Accumulator				
Total Number Required: 1				
Design Data				
Max Operating Pressure	1050 psia			
Design Pressure	1160 psia			
Max Operating Temperature	255 (1) °F			
Design Temperature	310 (1) °F			
Corrosion Allowance	in.			
Radiography	Per ASME Code			
Stress Relieved				
Code	ASME Code (Latest Edition)			
Estimated Weight (Empty)	lb			
Material Specification				
Shell -	Carbon Steel			
Internals -	None			
Lining -	None			
Supports -				
Insulation -	Heat Conservation			
Nozzle Schedule				
Nozzle	Mark No.	Qty.	Size, in.	Rating
Inlet	A	1	0.75 in.	600# RF
Outlet	B	1	0.75 in.	600# RF
Safety Valve	C	1	0.75 in.	600# RF
Drain	D	1	0.75 in.	600# RF
Level Gauge	E	1	1.0 in.	3000# NPT
Level Gauge	F	1	1.0 in.	3000# NPT
Pressure Gauge	G	1	0.75 in.	3000# NPT
Temperature Gauge	H	1	1.0 in.	3000# NPT



Remarks:

1. To be verified with air compressor vendor.
2. Ellipsoidal heads.
3. Final complete data sheet subjected to Kenox approval.

PROJECT: IT Corporation - TNT Red Water						KENOX	PROJECT NO.		DIVISION NO.								
							UJ41014										
							EQUIPMENT NO.		REV.								
							D-103		0								
CLIENT: IT Corporation						LOCATION:		SHEET 1 OF 1									
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0	11/21/94	For Quotation	BM														
NO.	DATE	REVISION	BY	CHK.	APP.												

VERTICAL VESSEL DATA SHEET

Equipment Name: **Feed Drum**
 Total Number Required: **1**

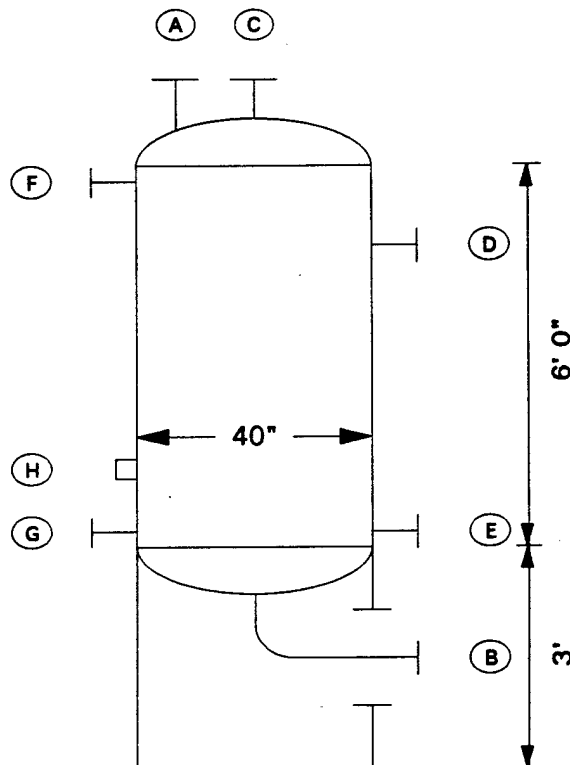
Design Data

Max Operating Pressure: **15** psia
 Design Pressure: **30** psia
 Max Operating Temperature: **85** °F
 Design Temperature: **135** °F
 Corrosion Allowance: **in.**
 Radiography: **Per ASME Code**
 Stress Relieved:
 Code: **ASME Code (Latest Edition)**
 Estimated Weight (Empty): **lb**

Material Specification



Shell - **316SS**
 Internals - **Note (1)**
 Lining -
 Supports - **Carbon Steel (skirt)**
 Insulation - **No**

Nozzle Schedule				
Nozzle	Mark No.	Qty.	Size, in.	Rating
Inlet	A	1	0.50 in.	150# RF
Outlet & Drain	B	1	1.0 in.	150# RF
Vent	C	1	1.0 in.	150# RF
Level Gauge	D	1	1.50 in.	150# RF
Level Gauge	E	1	1.50 in.	150# RF
Level Switch	F	1	1.0 in.	150# RF
Hand Hole	G	1	8.0 in.	150# RF
Sample Point	H	1	0.75 in.	3000# NPT



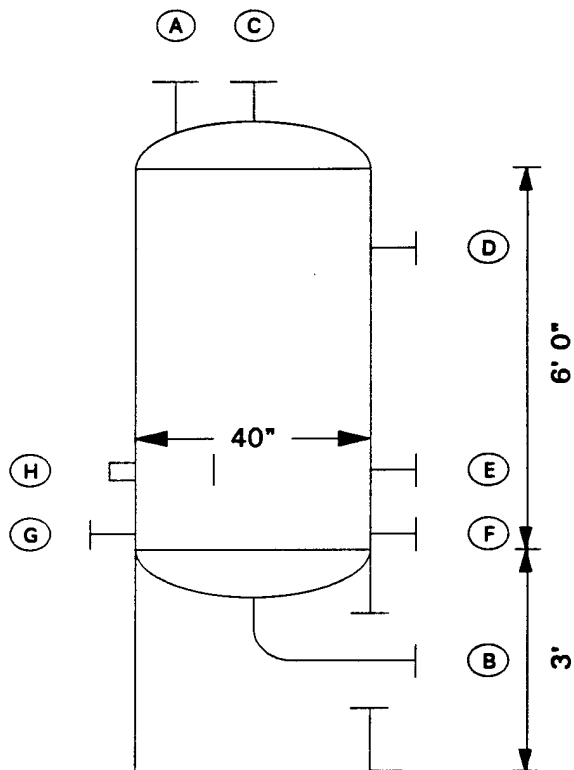
Remarks:

1. Vortex breaker at liquid outlet to be provided.
 2. Ellipsoidal heads.
 3. Final complete data sheet subjected to Kenox approval.

PROJECT:						KENOX	PROJECT NO.		DIVISION NO.	
IT Corporation - TNT Red Water							UJ41014			
							EQUIPMENT NO.		REV.	
1	12/22/94	Nozzle 'H' added	BM			CLIENT: IT Corporation	D-104		1	
0	11/16/94	For Quotation	BM							
NO.	DATE	REVISION	BY	CHK.	APP.	LOCATION:	SHEET		1 OF 1	

VERTICAL VESSEL DATA SHEET

Equipment Name: WAO Effluent Drum				
Total Number Required 1				
Design Data				
Max Operating Pressure	15	psia		
Design Pressure	30	psia		
Max Operating Temperature	107	°F		
Design Temperature	160	°F		
Corrosion Allowance		in.		
Radiography	Per ASME Code			
Stress Relieved				
Code	ASME Code (Latest Edition)			
Estimated Weight (Empty)		lb		
Material Specification				
Shell -	316SS			
Internals -	Note (1)			
Lining -				
Supports -	Carbon Steel (skirt)			
Insulation -	No			
Nozzle Schedule				
Nozzle	Mark No.	Qty.	Size, in.	Rating
Inlet	A	1	0.50 in.	150# RF
Outlet & Drain	B	1	1.0 in.	150# RF
Vent	C	1	1.0 in.	150# RF
Level Gauge	D	1	1.50 in.	150# RF
Level Gauge	E	1	1.50 in.	150# RF
Level Switch	F	1	1.0 in.	150# RF
Hand Hole	G	1	8.0 in.	150# RF
Sample Point	H	1	0.75 in.	3000# NPT



Remarks:

1. Vortex breaker at liquid outlet to be provided.
2. Ellipsoidal heads.
3. Final complete data sheet subjected to Kenox approval.

PROJECT:

IT Corporation - TNT Red Water

KENOX

PROJECT NO.

UJ41014

DIVISION NO.

EQUIPMENT NO.

D-105

REV.

1

CLIENT:

IT Corporation

LOCATION:

NO.	DATE	REVISION	BY	CHK.	APP.
1	12/21/94	Nozzle 'H' added	BM		<i>[Signature]</i>
0	11/16/94	For Quotation	BM		<i>[Signature]</i>

SHEET 1 OF 1

HEAT EXCHANGER DATA SHEET

E-101 REACTOR FEED/EFFLUENT EXCHANGER

Size	Type: Double Pipe	(Horiz/Vert) Horiz.	Connected In
Surf/Unit	Shells/Unit	Eff. Surf/Shell	ft2

PERFORMANCE OF ONE UNIT

		SHELL SIDE		TUBE SIDE	
Fluid Name		Oxidized Wastewater		Feed	
Fluid Quantity, Total lb/h		2007		1544	
		IN	OUT	IN	OUT
Vapour	lb/h	1043	646		
Liquid	lb/h	964	1361	1544	1544
Steam	lb/h				
Water	lb/h				
Noncondensable	lb/h				
Temperature	°F	483	403	61	362
Density	Liquid/ Vapour + NC lb/cf	53.00/2.52	55.45/3.01	66.67/	57.52/
Viscosity	Liquid/ Vapour + NC cP	0.10/0.02	0.10/0.02	1.27/	0.10/
Molecular Weight	Liquid/ Vapour + NC				
Molecular Weight, Noncondensable					
Specific Heat	Liquid/ Vapour + NC Btu/lb°F	1.19/0.44	1.08/0.33	0.91/	1.00/
Thermal Conductivity	Liquid/ Vapour + NC Btu/hrft-F	0.34/0.03	0.37/0.02	0.34/	0.38/
Latent Heat	Btu/lb				
Inlet Pressure	psia	990		1050	
Velocity	ft/s				
Pressure Drop, Allow/Calc	psi	10/		20/	
Fouling Resistance	hft2°F/Btu	0.002		0.002	
Heat Exchanged	430577 Btu/h ;MTD (Corrected)		213		°F
Transfer Rate	Service Clean				Btu/hft2°F

CONSTRUCTION OF ONE SHELL

		SHELL SIDE	TUBE SIDE	SKETCH
Design / Test Pressure	psig	1090/	1160/	
Design Temperature	°F	535	415	
No of Passes per Shell				
Corrosion Allowance	in			
Connection in (Size & Rating)		600#	600#	
Connection out (Size & Rating)		600#	600#	
Tube No	; OD	Thickn	Length	Pitch
Tube Type	Plain		Material	Titanium
Shell	Titanium ;ID	in; OD	in	Shell Cover (Integ.)
Channel or Bonnet				Channel Cover
Tubesheet - St				Tubesheet - FI
Floating Head Cover				Impingement Protection yes
Baffles - Cross	; Type	Vert/Seg	; %Cut(Area)	; Spacing c/c in
Baffles - Long	-		Seal Type	
Supports - Tube	U Bend		Type	
Bypass Seal Arrangement			Tube - Tubesheet Joint	
Expansion Joint			Type	
pv2 - Inlet Nozzle	-Bundle Entrance		- Bundle exit	
Gaskets - Shellside			- Tubeside	
- Floating Head				
Code	ASME Section VIII, Div I latest issue			
Weight/ Shell	Filled with Water		Bundle	Lb.

Remarks: (1) : Exchanger Vendor to confirm and supply all applicable information to fully complete data sheet.

(2): Material: Shellside = Titanium; Tubeside = Titanium

PROJECT: IT Corporation - TNT Redwater						KENOX		PROJECT NO.		DIVISION NO.	
								UJ41014			
						CLIENT: IT Corporation		EQUIPMENT SPEC. NO.		REV.	
								E-101		0	
						LOCATION:		SHEET 1 OF 1			
0	94/11/21	Initial	BM								
NO.	DATE	REVISIONS	BY	CHK.	APP.						

ELECTRIC HEATER

Equipment Name Reactor Feed Heater

Line, Size / Spec. 0.5 in. / 660

Duty, KW: 95

Fluid Name TNT Red Water

Fluid Quantity, Total lb/hr 772

Vapour lb/hr

Liquid lb/hr 772

Steam lb/hr

Water lb/hr

Noncondensable lb/hr

Temperature Deg F In: 61 Out: 480

Inlet Pressure psia 1050 Allowable Pressure Drop, psi: 20

Specific Gravity 1.07

Viscosity, Liquid cp 1.28

CONSTRUCTION

Design Pressure ,psia 1160

Design Temperature , Deg F 530

Flange Size, in: Rating:

Material, Shell: Titanium Note (7) Element: Ti, non-direct contact. See Note (4).

Voltage

Wattage

Length, mm

Wall Sheath thickness, mm

Welded Elements :

Built-in Thermostat well - Note 5 ☐ No ☒ Yes, Length,mm: I.D.,mm :

Vented or Stilted Housings required

Built-in Thermocouples

Passivated sheet required ?

Moisture resistant terminal housing required?

Code

Class: I & II Division : 1 Group :

Manufacturer:

Model Number:

- Remarks:**
- 1) Equipment vendor to insert all applicable data to fully complete data sheet.
 - 2) Final data sheet is subject to Kenox approval.
 - 3) Auto ignition temperature 295 to 330 deg C.
 - 4) Heating elements to be capsulated so that process fluid does not come in contact with the elements.
 - 5) Vendor to supply temperature trip on power supply for element high temperatures.
 - 6) Operation of the heater will be intermittent.
 - 7) Shell to be supplied by Kenox.

PROJECT:
IT Corporation - TNT redwater

KENOX

PROJECT NO. **DIVISION NO.**

UJ41014

EQUIPMENT NO. **REV.**

E-102

0

CLIENT:
IT Corporation

LOCATION:

0	11/22/94	For Quotation	BM		
NO.	DATE	REVISION	BY	CHK.	APP.

SHEET 1 **OF** 1

HEAT EXCHANGER DATA SHEET

Equipment Name EFFLUENT COOLER									
Type: Double Pipe		(Horiz/Vert) HORIZ		Connected In					
Surf/Unit ft2		Shells/Unit		Eff. Surf/Shell				ft2	
PERFORMANCE OF ONE UNIT									
				SHELL SIDE		TUBE SIDE			
Fluid Name				Cooling Water		Oxidized Waste Water			
Fluid Quantity, Total lb/h				33935		2007			
				IN		OUT		IN	
Vapour lb/h								646 516	
Liquid lb/h								1361 1491	
Steam lb/h									
Water lb/h				33935		33935			
Noncondensable lb/h									
Temperature °F				68		86		403 104	
Density		Liquid/ Vapour + NC lb/cf		63.13		62.66		55.45/3.01 64.66/5.18	
Viscosity		Liquid/ Vapour + NC cP		1		0.797		0.1/0.02 0.76/0.02	
Molecular Weight		Liquid/ Vapour + NC							
Molecular Weight, Noncondensable									
Specific Heat		Liquid/ Vapour + NC Btu/lb °F		0.97		0.97		1.078/0.331 0.946/0.27	
Thermal Conductivity		Liquid/ Vapour + NC Btu/hrft-F		0.349		0.357		0.374/0.023 0.359/0.017	
Latent Heat		Btu/lb							
Inlet Pressure		psia		60		980			
Velocity		ft/s							
Pressure Drop, Allow/Calc		psi		10/		10/			
Fouling Resistance		hft2 °F/Btu		0.001		0.002			
Heat Exchanged		588919 Btu/h		;MTD (Corrected)		129		°F	
Transfer Rate		Service		Clean				Btu/hft2 °F	
CONSTRUCTION OF ONE SHELL									
		SHELL SIDE		TUBE SIDE		SKETCH			
Design / Test Pressure psig		720/		1080/					
Design Temperature °F		140		455					
No of Passes per Shell									
Corrosion Allowance in									
Connection in (Size & Rating)		600#		600#					
Connection out (Size & Rating)		600#		600#					
Tube No		; OD		Thickn		Length		Pitch in	
Tube Type		Plain				Material		Titanium	
Shell		Carbon Steel ;ID		in; OD		in		Shell Cover Carbon Steel (Integ.)	
Channel or Bonnet						Channel Cover			
Tubesheet - Stationary						Tubesheet - Floating			
Floating Head Cover						Impingement Protection		yes	
Baffles - Cross		; Type				%Cut(Area)		; Spacing c/c in	
Baffles - Long		-				Seal Type			
Supports - Tube		U Bend				Type			
Bypass Seal Arrangement						Tube - Tubesheet Joint			
Expansion Joint						Type			
pv2 - Inlet Nozzle		-Bundle Entrance				- Bundle exit			
Gaskets - Shellside						- Tubeside			
- Floating Head									
Code		ASME Section VIII, Div I latest issue		; TEMA Class		R			
Weight/ Shell		Filled with Water				Bundle		Lb.	
Remarks: (1) : Exchanger Vendor to confirm and supply all applicable information to fully complete data sheet. (2): Material: Shellside = Carbon Steel; Tubeside = Titanium									
PROJECT:						KENOX		PROJECT NO.	
IT Corporation - TNT Redwater								UJ41014	
						CLIENT: IT Corporation		DIVISION NO.	
						LOCATION:		EQUIPMENT SPEC. NO.	
0 11/21/94 Initial BM <i>[Signature]</i>								REV.	
NO.		DATE		REVISIONS		BY		CHK.	
								APP.	
						SHEET		1 OF 1	

CENTRIFUGAL PUMP DATA SHEET

Equipment Name P-101 - Waste Feed Pump
Total Number Required One

Design Data				Motor	
Service Raw Wastewater				Motor hp	
Erosion/Corrosion				Volts 460	Phase 3 Hertz 60
	Min.	Norm	Max.	Electrical Classification Class I & II; Div. 1	
Pump Temperature	F	60			
Specific Gravity		1.08			
Viscosity	cP	1.2078			
Vapour Pressure	psia	14.7		Turbine	
Flow Rate	lb/hr	772		Inlet Steam Temp.	F
Solids Percent	Notes 2 & 3	15	30	Inlet Steam Pressure	psia
Pressure for Max. Flow				Exhaust Steam Temp	F
Suction Press.		16	psia	Exhaust Steam Pressure	psia
Discharge Pressure		46	psia		
Diff. Press.		30	psi		
Diff. Head		64	ft		
Min. NPSHA		5	ft		
Hyd hp	0.04 bhp				
Materials				Pump Connections	
API Spec 610				Suction Size	, Rating CI. 3000 NPT
Case	316SS			Discharge Size	, Rating CI. 3000 NPT
Shaft	316SS				
Impeller	316SS				
Packing Type					
Mechanical Seal Type					

Remarks: 1) Supplier to insert all applicable data to fully complete the data sheet.
 2) Total Suspended Solids: 1% maximum.
 3) Consider solids abrasive.

PROJECT: IT Corporation - TNT Redwater						KENOX		PROJECT NO. UJ41014		DIVISION NO.																	
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CLIENT: IT Corporation						LOCATION:		SHEET		1 OF 1																	
NO.	DATE	REVISION	BY	CHK.	APP.																						

CENTRIFUGAL PUMP DATA SHEET

Equipment Name P-102 - Dilution Feed Pump
Total Number Required One

Design Data				Motor	
Service		Service Water		Motor hp	
Erosion/Corrosion				Volts	460 Phase 3 Hertz 60
	Min.	Norm	Max.	Electrical Classification Class I & II; Div. 1	
Pump Temperature	F	60			
Specific Gravity		1.015			
Viscosity	cP	1.1197			
Vapour Pressure	psia	14.7		Turbine	
Flow Rate	lb/hr/GPM	1544/3		Inlet Steam Temp.	F
Solids Percent		0		Inlet Steam Pressure	psia
Pressure for Max. Flow				Exhaust Steam Temp	F
Suction Press.		16	psia	Exhaust Steam Pressure	psia
Discharge Pressure		46	psia		
Diff. Press.		30	psi		
Diff. Head		68	ft		
Min. NPSHA		5	ft		
Hyd hp	0.07	bhp			
Materials				Pump Connections	
API Spec 610				Suction Size	, Rating Cl. 3000 NPT
Case		316SS		Discharge Size	, Rating Cl. 3000 NPT
Shaft		316SS			
Impeller		316SS			
Packing Type					
Mechanical Seal Type					

Remarks: 1) Supplier to insert all applicable data to fully complete the data sheet.

PROJECT: IT Corporation - TNT Redwater						KENOX	PROJECT NO.		DIVISION NO.	
							UJ41014			
						EQUIPMENT NO.		REV.		
						P-102		0		
CLIENT: IT Corporation LOCATION:						SHEET		1 OF 1		
NO.	DATE	REVISION	BY	CHK.	APP.					
0	11/11/94	For Quotation	BM		<i>[Signature]</i>					

POSITIVE DISPLACEMENT PUMP DATA SHEET

Equipment Name P-103 High Pressure Feed Pump
 Total Number Required One

Design Data				Motor	
Service Raw Waste Water				Motor hp	
Erosion/Corrosion				Volts	460 Phase 3 Hertz 60
	Min.	Norm	Max.	Electrical Classification Class I, II Div.1	
Pump Temperature	F	60		Variable Speed Drive Required: Yes	
Specific Gravity		1.065			
Viscosity	cP	1.206			
Vapour Pressure	psia	14.7		Turbine	
Flow Rate	lb/hr	1544		Inlet Steam Temp. F	
Solids Percent	Notes 2 & 3	15	30	Inlet Steam Pressure psia	
Pressure for Max. Flow				Exhaust Steam Temp F	
Suction Press.		20	psia	Exhaust Steam Pressure psia	
Discharge Pressure		1050	psia		
Diff. Press.		1030	psi		
Diff. Head		2224	ft		
Min. NPSHA		5	ft		
Hyd hp	2.3 bhp				
Materials				Pump Connections	
Displacement Chamber		316SS		Suction Size	in.
Casing		316SS		Discharge Size	in.
Plunger Piston					
Diaphragm					
Check valves & Seats		316SS			
Shaft					
Packing Type					
Mechanical Seal Type					

Notes:

- 1) Supplier to insert all applicable data to fully complete the data sheet.
- 2) Total Suspended Solids: 1 % maximum.
- 3) Consider solids abrasive.

PROJECT: IT Corporation - TNT Redwater						KENOX		PROJECT NO. UJ41014		DIVISION NO.	
								EQUIPMENT NO. P-103		REV. 0	
CLIENT: IT CORPORATION						LOCATION:					
NO. DATE REVISION BY CHK. APP.											
								SHEET 1 OF 1			

CENTRIFUGAL PUMP DATA SHEET

Equipment Name P-105 - Final Effluent Pump
 Total Number Required One

Design Data				Motor	
Service Oxidized Wastewater				Motor hp	
Erosion/Corrosion				Volts 460	Phase 3
	Min.	Norm	Max.	Hertz 60	
				Electrical Classification Class I & II; Div. 1	
Pump Temperature	F	107			
Specific Gravity		1.03			
Viscosity	cP	0.733			
Vapour Pressure	psia	25		Turbine	
Flow Rate	lb/hr	772	1544	Inlet Steam Temp.	F
Solids Percent	Notes 2 & 3	15	30	Inlet Steam Pressure	psia
Pressure for Max. Flow				Exhaust Steam Temp	
Suction Press.		18	psia	Exhaust Steam Pressure	
Discharge Pressure		53	psia		
Diff. Press.		35	psi		
Diff. Head		78	ft		
Min. NPSHA		5	ft		
Hyd hp	0.08 bhp				
Materials				Pump Connections	
API Spec 610				Suction Size	, Rating Cl. 3000 NPT
Case	316SS			Discharge Size	, Rating Cl. 3000 NPT
Shaft	316SS				
Impeller	316SS				
Packing Type					
Mechanical Seal Type					

Remarks: 1) Supplier to insert all applicable data to fully complete the data sheet.
 2) Total Suspended Solids: 1% maximum.
 3) Consider solids abrasive.

PROJECT:						PROJECT NO.		DIVISION NO.	
IT Corporation - TNT Redwater						UJ41014			
						EQUIPMENT NO.		REV.	
						P-105		0	
CLIENT:						SHEET		1 OF 1	
IT Corporation						LOCATION:			
0 11/11/94 For Quotation BM APP.						1			
NO. DATE REVISION BY CHK. APP.						1			

SECTION 6.0.

UTILITY CONSUMPTION

6.0. UTILITY CONSUMPTION

6.1. ELECTRICAL

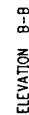
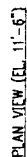
• Waste Feed Pump, KW	0.5
• Dilution Feed Pump, KW	0.5
• High Pressure Feed Pump, KW	1.6
• Final Effluent Pump, KW	0.75
• Air Compressor, KW	60
• Electric Heater, KW	95
• Reactor Section, KW	4

6.2. COOLING WATER

• Effluent Cooler, USGPM	68
• Air Compressor, USGPM	12
• Reactor Section, USGPM	15

SECTION 7.0.

GENERAL ARRANGEMENT DRAWINGS



1. PIPING ARRANGEMENT ILLUSTRATES PROCESS AND COMPRESSED AIR PIPING ONLY. SPECIFICALLY TO ASSIST IN DETERMINING THE BEST SITED LOCATIONS FOR EQUIPMENT AND C.V. SETS. VENTS, DRAINS AND UTILITY PIPING ARE NOT SHOWN.
2. UPPER LEVEL HAND RAIL IS DISCONTINUOUS ALONG COLUMN LINE 1.

EQUIPMENT LAYOUT (ELEVATION 11'-6")
USAC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

[illegible]

AD REF: 1741904 DONG

SECTION 8.0.

ELECTRICAL ONE LINE DRAWING

SECTION 9.0.

MASS & ENERGY BALANCE OUTPUTS

9.2. REACTOR PROCESS CONDITIONS

Process conditions assumed for the reactors in the process simulation model are: 484 deg F reaction temperature and 1000 psia operating pressure. The raw red water feed needed to be diluted to 6% to prevent excessive evaporation in the reactors resulting from the exothermic heat of reaction released during the oxidation reaction.

SECTION 9.3.

MASS & ENERGY BALANCE OUTPUT

USAEC - RED WATER:

MASS & ENERGY BALANCE

KENOX WAO

Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation
Date 94/11/22 Version C2.50 Case Name TEST1000.SIM
Time 15:34:49 Prop Pkg PRSV

DESIGN BASE CASE: RAW RED WATER FEED @ 12% COD; DILUTED TO 6%
Report Page: S- 1

Stream	2	3	4	5	6
Description	FEED	FEED2	HPFEED1	OUTE101TS	INE101SS
Vapour frac. F	0.0000	0.0000	0.0000	0.0000	0.4850
Temperature	60.0000*	59.7532	60.7666	361.8664	483.4641
Pressure	25.0000*	25.0000	1050.0000*	1000.0000	990.0001
Molar Flow lbmole/hr	36.8230	77.3206	77.3206	77.3206	94.8622
Mass Flow lb/hr	772.0500*	1544.1000	1544.1000	1544.1000	2007.3319
LiqVol Flow USGPM	1.4674	2.9672	2.9672	2.9672	4.1547
Enthalpy Btu/hr	-588750.2051	-1.22435E+06	-1.21847E+06	-787902.3763	-78511.3665
Density lb/ft3	67.4165	66.4393	66.6680	57.5167	4.6516
Mole Wt.	20.9665	19.9701	19.9701	19.9701	21.1605
Std Density lb/ft3	67.4113	---	66.5454	66.5454	---
H2O lb/hr	647.3350*	1367.7251	1367.7251	1367.7251	1390.5592
Nitrogen lb/hr	0.0000*	0.0011	0.0011	0.0011	368.5172
Oxygen lb/hr	0.0000*	0.0004	0.0004	0.0004	18.6829
CO2 lb/hr	0.0000*	0.2705	0.2705	0.2705	130.4247
H2SO4 lb/hr	43.6500*	90.6462	90.6462	90.6462	90.6747
35NitroToluelb/hr	81.0650*	85.4566	85.4566	85.4566	8.4732
Total: lb/hr	772.0500*	1544.1000	1544.1000	1544.1000	2007.3319

USAEC - RED WATER

MASS & ENERGY BALANCE

REVISION : 0

DATE :11/29/94

BY : BM

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KENOX Corporation

USAEC - RED WATER:

MASS & ENERGY BALANCE

KENOX WAO

Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation
 Date 94/11/22 Version C2.50 Case Name TEST1000.SIM
 Time 15:34:49 Prop Pkg PRSV

DESIGN BASE CASE: RAW RED WATER FEED @ 12% COD; DILUTED TO 6% Report Page: S- 2

Stream No.	7	8	9	10	11
Description	OUTE101SS	OUTE103SS	WAOEFFLP	WAOEFF	RCYCLEFF
Vapour frac.	0.2531	0.1760	0.0004	0.0000	0.0000
Temperature F	403.2996	104.0000*	106.7507	106.7507	106.7507*
Pressure psia	980.0001	970.0000	50.0000*	25.0000	50.0000*
Molar Flow lbmole/hr	94.8622	94.8622	78.1686	78.1346	40.4976*
Mass Flow lb/hr	2007.3319	2007.3319	1490.9379	1489.5666	772.0500
LiqVol Flow USGPM	4.1547	4.1547	2.8969	2.8936	1.4997
Enthalpy Btu/hr	-509088.2830	-1.09800E+06	-1.16006E+06	-1.16021E+06	-601346.9909
Density lb/ft3	8.3965	16.3581	54.8231	64.4474	64.4473
Mole Wt.	21.1605	21.1605	19.0734	19.0641	19.0641
Std Density lb/ft3	---	---	---	65.6963	65.6963
H2O lb/hr	1390.5592	1390.5592	1389.9085	1389.8936	720.3901*
Nitrogen lb/hr	368.5172	368.5172	0.1698	0.0022	0.0011*
Oxygen lb/hr	18.6829	18.6829	0.0237	0.0008	0.0004*
CO2 lb/hr	130.4247	130.4247	1.6878	0.5220	0.2705*
H2SO4 lb/hr	90.6747	90.6747	90.6747	90.6747	46.9962*
35NitroToluelb/hr	8.4732	8.4732	8.4732	8.4732	4.3916*
Total: lb/hr	2007.3319	2007.3319	1490.9379	1489.5666	772.0500

USAEC - RED WATER
 MASS & ENERGY BALANCE

REVISION : 0 DATE :11/29/94
 BY : BM

PAGE

KENOX Corporation

USAEC - RED WATER:

MASS & ENERGY BALANCE

KENOX WAO

Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation
 Date 94/11/22 Version C2.50 Case Name TEST1000.SIM
 Time 15:34:49 Prop Pkg PRSV

DESIGN BASE CASE: RAW RED WATER FEED @ 12% COD; DILUTED TO 6% Report Page: S- 3

Stream No.	12	15	16	17	18
Description	PRODUCT	OFFGAS1	OFFGAS	AIRTOTAL	AIRTOR101
Vapour frac.	0.0000	1.0000	1.0000	1.0000	1.0000
Temperature F	106.7507	64.6701	64.7622	255.0000*	255.0000
Pressure psia	50.0000	20.0000*	20.0000	1000.0000*	1000.0000
Molar Flow lbmole/hr	37.6370	16.6936	16.7276	16.0624	8.0312
Mass Flow lb/hr	717.5166	516.3940	517.7653	463.2300*	231.6150
LiqVol Flow USGPM	1.3938	1.2578	1.2612	1.0704	0.5352
Enthalpy Btu/hr	-558871.0148	62059.7502	62207.5463	78070.0490	39035.0245
Density lb/ft3	64.4474	0.1101	0.1102	3.7205	3.7205
Mole Wt.	19.0641	30.9337	30.9528	28.8394	28.8394
Std Density lb/ft3	65.6963	---	---	---	---
H2O lb/hr	669.5046	0.6506	0.6655	0.0000*	0.0000
Nitrogen lb/hr	0.0011	368.3473	368.5150	356.6871*	178.3435
Oxygen lb/hr	0.0004	18.6592	18.6820	106.5429*	53.2715
CO2 lb/hr	0.2514	128.7369	129.9028	0.0000*	0.0000
H2SO4 lb/hr	43.6775	0.0000	0.0000	0.0000*	0.0000
35NitroToluelb/hr	4.0815	0.0000	0.0000	0.0000*	0.0000
Total: lb/hr	717.5166	516.3940	517.7653	463.2300*	231.6150

USAEC - RED WATER

MASS & ENERGY BALANCE

REVISION: 0 DATE: 11/29/94

BY: BM

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KENOX Corporation

USAEC - RED WATER:

MASS & ENERGY BALANCE

KENOX WAO

Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation
 Date 94/11/22 Version C2.50 Case Name TEST1000.SIM
 Time 15:34:49 Prop Pkg PRSV

DESIGN BASE CASE: RAW RED WATER FEED @ 12% COD; DILUTED TO 6% Report Page: S- 4

Stream No.	19	20	21
Description	AIRTOR102	CWIN	CWOUT
Vapour frac.	1.0000	0.0000	0.0000
Temperature F	255.0000	68.0000*	86.0000*
Pressure psia	1000.0000	60.0000*	50.0000
Molar Flow lbmole/hr	8.0312	1883.6746	1883.6746
Mass Flow lb/hr	231.6150	33934.5875	33934.5875
LiqVol Flow USGPM	0.5352	67.9084	67.9084
Enthalpy Btu/hr	39035.0245	-2.77338E+07	-2.71449E+07
Density lb/ft3	3.7205	63.1274	62.6571
Mole Wt.	28.8394	18.0151	18.0151
Std Density lb/ft3	---	63.3284	63.3284
H2O lb/hr	0.0000	33934.5874*	33934.5874
Nitrogen lb/hr	178.3435	0.0000*	0.0000
Oxygen lb/hr	53.2715	0.0000*	0.0000
CO2 lb/hr	0.0000	0.0000*	0.0000
H2SO4 lb/hr	0.0000	0.0000*	0.0000
35NitroToluelb/hr	0.0000	0.0000*	0.0000
Total: lb/hr	231.6150	33934.5875	33934.5875

USAEC - RED WATER

MASS & ENERGY BALANCE

REVISION : 0 DATE :11/29/94

BY : BM

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KENOX Corporation

SECTION 10.0.

PILOT PLANT COST ESTIMATES

10.0. PILOT PLANT COST ESTIMATE

10.1. SCOPE OF KENOX SUPPLY

Kenox shall supply IT Corporation's client with the following services and equipment:

- Basic Process Engineering Design Package.
- Detailed engineering, procurement, manufacturing/fabrication and assembly of the total Kenox skid mounted system.
- Kenox' skid mounted system includes all equipment as per the equipment list in Section 4, fabrication and installation of piping within the skid battery limit and instrumentation.
- Separate trailer unit to contain DCS and MCC.
- All vessels and piping within the skid battery limits requiring insulation will be insulated.
- All electrical equipment and materials within the skid arrangement to be pre-installed and terminated at junction boxes.
- Operating and maintenance manuals.

10.2. SCOPE OF IT CORPORATION SUPPLY

IT Corporation or its client shall supply the following equipment and services:

- Foundation and drainage system to accommodate Kenox skid mounted system.
- All utility connections to and from Kenox system.
- Unpacking and locating the skid in the designated area.
- Electrical interconnecting wiring and conduit between skid mounted Kenox supplied junction boxes and Kenox supplied trailer unit.
- Power feed to Kenox disconnect switch at power distribution panel.
- Appropriate system registration with governing State authorities.

10.3. PURCHASE OPTION

The price for a fully operational skid mounted plant capable of treating TNT red water in a continuous operation at the rate of 3 USGPM delivered CIF Toronto, Ontario, Canada is \$ 1,900,000 US - 5% + 15 %. This price is valid for 90 days from the date of this proposal.

The cost of shipment, insurance, transportation to IT Corporation or its client and all applicable federal and state taxes and permits will be on the account of the purchaser.

The price quoted includes the scope of supply by Kenox Corporation as outlined in Section 10.1.

10.4. LEASE OPTION

The cost schedule for the leasing option is outlined below:

- 4 equal payments of \$225,000 US
- first payment due upon signing of the purchase order
- second payment due on delivery of the equipment to the site
- third payment due 90 days after delivery of the equipment to the site
- fourth payment due 120 days after delivery of the equipment to the site
- the cost of shipment, insurance, transportation to IT Corporation or its client and return to Kenox and all applicable federal and state taxes and permits will be on the account of the purchaser.
- operations and maintenance costs not included

The leasing cost and terms are valid for 90 days from the date of this proposal.

Kenox will be pleased to provide additional information, if required, at the time the contract is negotiated.

SECTION 11.0.

OPERATIONS & SAFETY CONSIDERATIONS

11.0. OPERATIONS & SAFETY CONSIDERATIONS

11.1. INTRODUCTION

This section presents a description of special health and safety precautions related to the operations and sampling of a Kenox Wet Air Oxidation system for the treatment of red water.

11.2. REGULATIONS AND GUIDELINES

All activities conducted during the wet air oxidation of red water must be in compliance with applicable requirements of the following publications:

- 29 Code of Federal Regulations (CFR) 1926, Construction Industry, OSHA Safety and Health Standards
- 29 CFR 1910, General Industry OSHA Safety and Health Standards
- 29 CFR 1910.120, OSHA Final Rule dated March 6, 1989, "Hazardous Waste Operations and Emergency Response"
- NIOSH/OSHA/USCG/EPA, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985
- American Conference of Government Industrial Hygienists (ACGIH), "Threshold Limit Values and Biological Exposure Indices", 1989 - 1990, or most current version
- U.S. Department of Health and Human Services, (DHHS) "NIOSH Sampling and Analytical Methods," DHHS (NIOSH) Publication 84-100
- ANSI, Emergency Eyewash and Shower Equipment, Z41.1 (1983)
- ANSI, Protective Footwear, Z358.1 (1981)
- ANSI, Practice for Occupational and Educational Eye and Face Protection, Z87.1 (1968)
- ASTM D4687, Vol. 11.04, Standard Guide for General Planning of Waste Sampling, ASTM, Philadelphia, PA.

11.3. EMERGENCY SHUTDOWN SYSTEM

The prime area of concern is the reaction of the excess oxygen in the reactor system with an inadvertent introduction of an excess of oxidizable chemicals or a material (such as a combination of copper, iron and cobalt) that could act as a catalyst and increase the rate of reaction. The rapid oxidation would result in an increase in the reaction temperature and a corresponding increase in pressure. However, the pressure increase would be mitigated by the pressure control valve PCV-312 opening in response to the pressure surge.

The system is equipped with two levels of alarm. The first alarm, with indication on the CRT, warns of high temperature or high pressure in the system prior to activation of the Emergency Shutdown System.

The second alarm on high temperature or high pressure reading in the reactor system will trigger the Emergency Shutdown System. If the temperature sensor, TSHH-208, on the reactor system's outlet line senses a temperature over 500 °F (Note: this setting can be changed) or the high pressure sensor, PSHH-313, on the reactor system's outlet line senses a pressure over 1050 psig (resulting from a rapid pressure rise or a malfunction of pressure control valve, PCV-312), the WAO system will go into automatic shutdown as follows:

1. High temperature alarm is sounded with an indication on the CRT in the control room as to which sensor has activated the shutdown.
2. The microprocessor control unit will automatically initiate the following steps simultaneously:
 - Air to system is stopped by the closing of the emergency shutdown valve XCV-603 located on the outlet line from the air accumulator, D-103.
 - If the electric heater E-102 is in use, a signal will be sent to shut down the heater to prevent any additional heat from being introduced into the system.
 - The waste water feed to the system is stopped by closing of the feed shutdown valve XCV-601 located upstream of the high pressure feed pump, P-103.
 - Service water is introduced to the system by the full opening of the valve XCV-602 located upstream of P-103.

The operator should proceed as follows:

- Acknowledge the alarm.

- Lower the pressure on the system to 900 psig by resetting PCV-312.
- Increase the flow through the high pressure pump, P-103 to 4 USGPM.

All the above steps can be done from the CRT in the control room.

If the pressure and temperature sensors fail to respond or a fault occurs in the control system, then the pressure will be relieved via the safety relief valve PSV-317. A high pressure alarm, PAH-316 would indicate that either the relief valve has been activated or that the rupture disc is leaking. The relief valve will discharge to the atmosphere via a safe location. If the relief valve is activated then the operator should immediately implement the shutdown of the facility via pushing button HS-XXX on the panel or an equivalent icon on the CRT. The rupture disc PSE-314 should be replaced, relief valve settings rechecked and lines between the rupture disc and the safety valve cleaned to remove any residual waste lodged against PSH-316 and PI-315.

11.4. HAZARD ASSESSMENT

11.4.1 Waste Feed

Explosion Potential - Red water has a solids content of 15% and a solids heat content of 3200 BTU/lb. As the initial raw waste stream will be diluted with a recycle effluent stream and a very high reactor recycle stream prior to entering the reactor system (exceeding the 20:1 dilution factor), the effects of temperature and pressure excursions resulting from a detonation type of reaction is negligible. Section 11.3 discusses the Emergency Shutdown System in place to handle temperature and pressure excursions.

Contaminated Surfaces - The raw red water will be pumped to the feed drum from the client's storage tank located outside Kenox' battery limits. In the unlikely event that red water is spilled or leaked, it should be cleaned using wet methods and not be allowed to dry. If it is allowed to dry, the concentrated solids must be considered as explosive and susceptible to initiation by impact, friction, heat or electrostatic charge.

11.4.2 Burn Hazards

All equipment with surface temperatures over 100 deg F have been provided with insulation for personnel protection.

11.4.3 Confined Space Entry

The WAO system shall be evaluated during detailed engineering to determine if any spaces are permit required confined space. A permit required confined space is a space that:

- Contains or has the potential to contain a hazardous atmosphere
- Contains a material that has a potential for engulfing an entrant
- Is configured such that an entrant could be trapped or asphyxiated
- Contains any other safety or health hazard.

A sign reading, "DANGER - PERMIT - REQUIRED CONFINED SPACE, DO NOT ENTER" will be posted at the entrance to any confined space.

11.4.4 Sampling

Red water may present potential inhalation and skin contact hazards during the sampling and sample handling activities. Appropriate personal protective equipment should be worn (i.e. safety glasses, hand protection, apron). Material Safety Data Sheets on some major components of red water are presented in Section 11.4.5.

SECTION 11.4.5.

MATERIAL SAFETY DATA SHEETS

* M S D S *
*
* Canadian Centre for Occupational Health and Safety *

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 347777
PRODUCT NAME(S) : TNT
PRODUCT IDENTIFICATION : EXP 0032

*** MANUFACTURER INFORMATION ***

MANUFACTURER : ICI Canada Inc
ADDRESS : 90 Sheppard Avenue East
Box 200 Station "A"
North York Ontario
Canada M2N 6H2
Telephone: 416-229-7000
Telex: 06986505
Fax: 416-229-7752
EMERGENCY TELEPHONE NO. : 800-561-3636

*** MATERIAL SAFETY DATA ***

ICI Canada Inc.
P.O. Box 200, Station "A"
North York, Ontario
Canada, M2N 6H2

TNT

MATERIAL SAFETY DATA SHEET

Date Issued: 91 06 06

Index: EXP 0032/91B

FOR EMERGENCIES INVOLVING CHEMICAL SPILL OR RELEASE, CALL THE ICI CANADA
TRANSPORTATION EMERGENCY RESPONSE SYSTEM AT 1-800-561-3636.

PRODUCT IDENTIFICATION

Product Name: TNT
Chemical Name: 2,4,6-Trinitrotoluene
Synonyms: Methyltrinitrobenzene, alpha-TNT, Nitropel, TNT (TY1 Flake)
(Military Grade), TNT (Flake), Triton, Trinitrotoluol, Trotyl, Tolite,
Trinitrotoluene.
Chemical Family: High Explosives.
Molecular Formula: (NO2)3C6H2CH3
Product Use: Blasting agent. Manufacture of packaged explosives and primers
(cast explosive).

REGULATORY SECTION

Controlled Products Regulations Classification: This product is an explosive and is not regulated by CHMIS.

OSHA Hazard Communication (29CFR 1910.1200) Classification: Irritant (eye, skin and respiratory tract); skin sensitizer; explosive.

CANADIAN TDG ACT SHIPPING DESCRIPTION

Shipping Name: Trinitrotoluene (or TNT)
Shipping Class/Division: 1.1D
Product Identification No (PIN): UN0209
Packing Group: II

U.S. DOT Classification: Refer to the "Code of Federal Regulations."

Other Regulations: Not available.

Read the entire MSDS for the complete hazard evaluation of this product.

HAZARDOUS INGREDIENTS OF PRODUCT

Hazardous Ingredients	%(w/w)	ACGIH TLV	CAS No.
Trinitrotoluene	98-100	0.5 mg/m3	118-96-7

PHYSICAL PROPERTIES

Physical State: Solid.
Appearance and Odour: Pale yellow flakes or prills; practically odourless.
Odour Threshold: Not applicable.
Boiling Range (Deg. C): Decomposes at 270.
Melting/Freezing Point (Deg. C): 80.65 (pure TNT)
Vapour Pressure: 0.053 mmHg (@ 85 Deg. C).
Specific Gravity: 1.645 (crystals); 1.47 (molten) (water = 1).
Vapour Density: Not available.
Bulk Density: 0.94 g/cc
Evaporation Rate: Not applicable.
Solubility: 0.013 g/100 g of water at 20 Deg. C. Sparingly soluble in alcohol; soluble in benzene, toluene and acetone.
% Volatile by Volume: Not applicable.
pH: Not applicable.
Coefficient of Water/Oil Distribution: Not available.
Sensitivity to Mechanical Impact: One of the least sensitive of the high explosives. More sensitive in the liquid form than the solid.
Rate of Burning: Not available.
Explosive Power: 439 kJ/100 g
Sensitivity to Static Discharge: Not available.

REACTIVITY DATA

Stability:

Under Normal Conditions: Stable.

Under Fire Conditions: Flammable.

• Hazardous Polymerization: Will not occur.

Conditions to Avoid: Excessive heat, situations where product may be

confined, and prolonged exposure to sunlight.

Materials to Avoid: Strong oxidizers and reducing agents, alkaline materials and mineral acids.

Hazardous Decomposition or Combustion Products: When heated to decomposition, it emits toxic nitrogen oxide (NOx) fumes. Its combustion products include large amounts of black smoke and nitrogen oxide fumes (NOx).

FIRE AND EXPLOSION DATA

Flash Point (Deg. C) (Method): Not available.

Autoignition Temperature: Approx. 295-330 Deg. C.

Flammability Limits in Air (%): LEL: Not applicable.
UEL: Not applicable.

Fire Extinguishing Media: See below.

Fire Fighting Procedures: DO NOT FIGHT FIRES INVOLVING EXPLOSIVE MATERIALS. Immediately evacuate all personnel from the area.

Other Fire or Explosion Hazards: Not applicable.

TOXICOLOGICAL AND HEALTH DATA

Recommended Exposure Limit: See "HAZARDOUS INGREDIENTS OF PRODUCT" Section.

Toxicological Data:

Trinitrotoluene LD50 (oral, rat) = 795 mg/kg (1)

Carcinogenicity Data: The ingredient(s) of this product is (are) not classified as carcinogenic by ACGIH (American Conference of Governmental Industrial Hygienists) or IARC (International Agency for Research on Cancer), not regulated as carcinogens by OSHA (Occupational Safety and Health Administration), and not listed as carcinogens by NTP (National Toxicology Program).

Reproductive Effects: No information is available and no adverse reproductive effects are anticipated.

Mutagenicity Data: No information is available and no adverse mutagenic effects are anticipated.

Teratogenicity/Fetotoxicity Data: No information is available and no adverse teratogenic/embryotoxic effects are anticipated.

Synergistic Materials: None known.

EFFECTS OF EXPOSURE WHEN:

. Inhaled: Product is irritating to the nose, throat and respiratory tract. May cause central nervous system (CNS) depression, liver damage, kidney damage and methemoglobinemia. See "Other Health Effects" Section.

. In contact with the skin: This product may cause irritation due to

abrasive action. Prolonged and repeated contact may lead to dermatitis. May be absorbed through intact skin. May cause skin sensitization or other allergic responses. See "Other Health Effects" Section.

. In contact with the eyes: This product causes irritation, redness and pain. Prolonged and repeated contact may cause cataracts.

. Ingested: Ingestion of large amounts may cause nausea, gastrointestinal upset and abdominal pain. May cause central nervous system (CNS) depression, liver damage, kidney damage and methemoglobinemia. See "Other Health Effects" Section.

Other Health Effects: Initial manifestation of methemoglobinemia is cyanosis, characterized by navy blue, almost black lips, tongue, and mucous membranes, with skin colour being slate gray. Further manifestation is characterized by headache, weakness, dyspnea, dizziness, stupor, respiratory distress and death due to anoxia.

Signs and symptoms of kidney damage generally progress from oliguria, to blood in the urine, to total renal failure.

If ingested, Nitrates may be reduced to nitrites by bacteria in the digestive tract. Signs and symptoms of nitrite poisoning include cyanosis (due to methemoglobin formation), nausea, dizziness and increased heart rate.

CNS depression is characterized by headache, dizziness, drowsiness, nausea, vomiting and incoordination. Severe overexposures may lead to coma and possible death due to respiratory failure.

Sensitization is the process whereby a biological change occurs in the individual because of previous exposure to a substance and, as a result, the individual reacts more strongly when subsequently exposed to the substance. Once sensitized, an individual can react to extremely low airborne levels, even below the TLV, or to skin contact.

FIRST AID PROCEDURES WHEN:

. Inhaled: Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Obtain medical attention IMMEDIATELY.

. In contact with the skin: Flush skin with running water for a minimum of 20 minutes. Start flushing while removing contaminated clothing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY.

. In contact with the eyes: Immediately flush eyes with running water for a minimum of 20 minutes. Hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY.

. Ingested: If victim is alert and not convulsing, rinse mouth out and give 1/2 to 1 glass of water to dilute material. DO NOT induce vomiting. If spontaneous vomiting occurs, have victim lean forward with head down to avoid breathing in of vomitus, rinse mouth and administer more water. Obtain medical attention IMMEDIATELY.

Emergency Medical Care: Alcohol use may cause enhanced response to effects

of TNT exposure. Individuals deficient in glucose-6-phosphate dehydrogenase may be at greater risk. Medical conditions that may be aggravated by exposure to this product include cardiovascular diseases and liver, blood and kidney disorders.

PREVENTATIVE MEASURES

Recommendations listed in this section indicate the type of equipment which will provide protection against overexposure to this product. Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.

Engineering Controls: Local exhaust ventilation required, if the product itself is handled.

Respiratory Protection: A NIOSH/MSHA-approved air-purifying respirator equipped with combined dust, mist, fume/organic vapour cartridges for concentrations up to 5 mg/m³ TNT. An air-supplied respirator if concentrations are higher or unknown.

Skin Protection: Gloves and protective clothing made from cotton should be impervious under conditions of use. The use of coveralls is recommended.

Eye Protection: Safety glasses with side shields are recommended to prevent eye contact.

Other Personal Protective Equipment: Locate safety shower and eyewash station close to chemical handling area.

Handling Procedures and Equipment: This product is an explosive and should only be used under the supervision of an experienced blaster.

Storage Temperature (Deg. C): See below.

Storage Requirements: Dry, secure magazine that is properly grounded. Do not expose to temperatures above 35 Deg. C.

Other Precautions: Use only with adequate ventilation and avoid breathing dusts/vapours. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after handling. Wash contaminated clothing thoroughly before re-use.

ENVIRONMENTAL PROTECTION DATA

Steps to be Taken in the Event of a Spill or Leak: Stop and contain spill. Wet spilled material and sweep up into strong plastic bags or plastic containers. Keep the material wet. Avoid use of metal tools. Be careful to avoid shock, friction and sparks. Notify applicable government authority if release is reportable or could adversely affect the environment.

Environmental Effects: Harmful to aquatic life at low concentrations. A concentration of 1.5 mg/L is toxic to fish. Can be dangerous if allowed to enter drinking water intakes. Product has an unaesthetic appearance and can be a nuisance.

Deactivating Chemicals: None known.

Waste Disposal Methods: Do not dispose of waste with normal garbage to sewer systems. Burn under supervision of an expert at a government approved explosive burning ground or destroy, by detonation in boreholes, with explosives in accordance with applicable local, provincial and federal regulations. Call upon the services of an ICI Technical Representative.

ADDITIONAL INFORMATION AND SOURCES USED

1. RTECS-Registry of Toxic Effects of Chemical Substances, On-line search, Canadian Centre for Occupational Health and Safety RTECS database, Vol I-V, 1985-1986 edition, Doris V. Sweet, Ed., National Institute for Occupational Safety and Health, U.S. Dept. of Health and Human Services, Cincinnati, 1987.
 2. U.S. Dept. of Health and Human Services, NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards, NIOSH, U.S. Dept. of Labour, 1978.
 3. Explosives, R. Meyer, 2nd Edition, 1981, Verlag Chemie.
 4. M.W. Nay et al, J. Wat. Pollut. Control Fed., 1974, Volume 46, 485-497.
 5. Formula Book - Explosives, C-I-L Inc., Explosives, Research and Technical Department, current Edition.
 6. Chemistry and Technology of Explosives, Vol. 1, T. Vrbanski, Pergamon Press, 1983.
 7. Windholz, Martha, Ed., The Merck Index, 10th ed., Merck and Co. Inc., Rahway, New Jersey, 1983.
 8. Sax, N. Irving, Dangerous Properties of Industrial Materials, 7th ed., Van Nostrand Reinhold Co., New York, 1989.
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The information contained herein is offered only as a guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and ICI Canada Inc. will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein. This Material Safety Data Sheet is valid for three years.

Date Issued: 91 06 06

Date Revised: 91 06 06

MSDS Index No: EXP 0032/91B

Prepared By: Safety, Health and Environment (416) 229-8252

* * * * *
* M S D S *
*
* Canadian Centre for Occupational Health and Safety *
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*** IDENTIFICATION ***

MSDS RECORD NUMBER : 690925
PRODUCT NAME(S) : DNT Mixture
Dinitrotoluene Mixture
PRODUCT IDENTIFICATION : MSDS NUMBER: CEC00012
DATE OF MSDS : 1992-11-07

*** MANUFACTURER INFORMATION ***

MANUFACTURER : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** SUPPLIER/DISTRIBUTOR INFORMATION ***

SUPPLIER/DISTRIBUTOR : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** MATERIAL SAFETY DATA ***

DuPont
Material Safety Data Sheet

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Dinitrotoluene Mixture
CEC00012 Revised 7-NOV-1992 Printed 3-FEB-1994

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

CAS Number : 25321-14-6
Formula : CH3C6H3(NO2)2
CAS Name : Benzene, methyl dinitro
Grade : Technical

Tradenames and Synonyms

DNT Mixture

Company Identification

MANUFACTURER/DISTRIBUTOR

DuPont Canada, Inc.
P.O. BOX 2200
STREETSVILLE
MISSISSAUGA, ONTARIO L5M 2H3

PHONE NUMBERS

Product Information : 1-800-387-2122
Transport Emergency : 1-613-348-3616 (24 HOURS)
Medical Emergency : 1-613-348-3616 (24 HOURS)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
*2,4-Dinitrotoluene	121-14-2	76
*2,6-Dinitrotoluene	606-20-2	19
Other Mono/Di/Tri-nitrotoluene isomers		5

* Regulated as a Toxic Chemical under Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

HAZARDS IDENTIFICATION

Potential Health Effects

Harmful if inhaled or absorbed through skin; causes cyanosis. Symptoms may be delayed. Causes irritation.

Inhalation 1-hour LC50: >2.87 mg/l in rats - Data is
Skin absorption ALD: >1,000 mg/kg in rabbits for
Oral LD50: 177 mg/kg in rats 2,4-DNT

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(HAZARDS IDENTIFICATION - Continued)

2,4-DNT is an eye and skin irritant. Toxic effects described in animals from short exposures include nonspecific effects such as reduced weight gain, methemoglobinemia and effects on the central nervous system, the reproductive system, and the bone marrow. In tests with laboratory animals, technical grade 2,4-DNT has carcinogenic activity. Tests for mutagenic activity in bacterial and mammalian cell cultures have been inconclusive, with positive results in some studies, and negative results in others. Tests in animals demonstrate no developmental activity. 2,4-DNT produce testicular degeneration and decreased spermatogenesis in rats, mice, and dogs. Reduction in male fertility occurs in dominant lethal studies in rats.

2,6-DNT is a skin irritant, is not an eye irritant, and is a skin sensitizer in tests with laboratory animals. Toxic effects described in animals from exposure include methemoglobinemia, decreased spermatogenesis, testicular atrophy, anemia, paralysis and tremors. Tests with 2,6-DNT in some animals demonstrate carcinogenic activity, while tests for mutagenic activity in bacterial and mammalian cell cultures have been inconclusive with positive results in some studies, and negative results in others.

Human health effects of overexposure may initially include: reduction of the blood's oxygen carrying capacity with cyanosis (bluish discoloration), weakness, or shortness of breath by methemoglobin formation; abnormal blood forming system function with anemia; red blood cell destruction; nonspecific discomfort, such as nausea, headache or weakness; temporary nervous system depression with anaesthetic effects such as dizziness, headache, confusion, incoordination, and loss of consciousness; temporary lung irritation effects with cough, discomfort, difficulty breathing, or shortness of breath; or joint pain. All isomers appear to be able to significantly permeate the skin. There are no reports of human sensitization. Individuals with preexisting diseases of the cardiovascular system or bone marrow may have increased susceptibility to the toxicity of excessive exposures.

Carcinogenicity Information

The following components are listed by IARC, NTP, OSHA or ACGIH as carcinogens. A "P" indicates a proposed carcinogen.

Material	IARC	NTP	OSHA	ACGIH
Dinitrotoluene Mixture				X
2,4-Dinitrotoluene				X

Du Pont controls the following materials as potential carcinogens:
2,4-Dinitrotoluene.

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DuPont

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Material Safety Data Sheet

FIRST AID MEASURES

First Aid

In case of contact: Immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse and destroy contaminated shoes.

If inhaled: Remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Call a physician.

If swallowed: Induce vomiting immediately by giving two glasses of water and sticking finger down throat. Call a

physician. Never give anything by mouth to an unconscious person.

Note to Physician: Absorption of this product into the body leads to the formation of methemoglobin which, in sufficient concentration, causes cyanosis. In case of skin absorption, symptoms may be delayed. Since reversion of methemoglobin to hemoglobin occurs spontaneously after termination of exposure, moderate degrees of cyanosis need be treated only by supportive measures such as bed rest and oxygen inhalation. Thorough cleansing of the entire contaminated area of the body including scalp and nails is of utmost importance. If cyanosis is severe, intravenous injection of methylene blue, 1 mg/kg body weight, may be of value. Cyanocobalamin (Vitamin B-12), 1 mg intramuscularly, will speed recovery. Intravenous fluids and blood transfusions may be indicated in very severe exposures.

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point	: 173 C (343 F)
Method	: SFCC
Flammable limits in Air, % by Volume	
LEL	: *
UEL	: *
Autoignition	: * C
Autodecomposition	: 270 C (518 F)

*Not available

Fire and Explosion Hazards:

OSHA Class III B Combustible Material. Will burn. Fire or high temp., above 270 C (518 F), and confined material will cause an explosion (see also Decomposition).

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DuPont

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Material Safety Data Sheet

(FIRE FIGHTING MEASURES - Continued)

Extinguishing Media

Water, Dry Chemical.

Carbon dioxide (CO2)

Fire Fighting Instructions

Evacuate personnel to a safe area. Flood with water. Cool tank/container with water spray.

Do not attempt to fight large or advanced fires; material will explode if confined and heated above 270 C. Fight smaller fires with unmanned or remotely activated equipment. Run-off from fire control may cause pollution.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures

Evacuate area - admission should be limited to trained personnel wearing full protective equipment. If molten, dike, soak up with sand or other non-combustible absorbant and allow to freeze. Place solid material in a covered steel drum for disposal. Use non-sparking tools. Comply with Federal, State, and local regulations on reporting releases.

HANDLING AND STORAGE

Handling (Personnel)

Do not breathe vapor or mist. Do not breathe dust. Do not get on skin. Do not get on clothing. Do not get in eyes. Wash thoroughly after handling.

Use only with adequate ventilation.

Storage

Store in a well ventilated place.

Keep away from heat, sparks, and flame. Keep drums upright and tightly closed.

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EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Use in a totally closed system. Ventilation should be provided to keep concentration below the exposure limits.

Personal Protective Equipment

Eye/Face	: Coverall chemical splash goggles. Safety glasses (side shields); full-length face shield.
Respirator	: Air supplied respirator. Suitable respiratory protection & chem. proof suit w/hood.
Additional	: Butyl rubber apron and footwear

Protective Gloves: Neoprene or butyl gauntlet- lined if
handling hot material.

Exposure Guidelines

Exposure Limits

Dinitrotoluene Mixture

PEL (OSHA)	: 1.5 mg/m ³ , 8 Hr. TWA, Skin
TLV (ACGIH)	: 0.15 mg/m ³ , 8 Hr. TWA, A2, Skin
AEL * (Du Pont)	: None Established

Other Applicable Exposure Limits

2,4-Dinitrotoluene

PEL (OSHA)	: 1.5 mg/m ³ , 8 Hr. TWA, Skin
TLV (ACGIH)	: 1.5 mg/m ³ , 8-Hr. TWA, Skin
	Notice of Intended Changes (1993-1994)
	0.15 mg/m ³ , 8 Hr. TWA, A2, Skin
AEL * (Du Pont)	: 0.15 mg/m ³ , 8 & 12 Hr. TWA, Skin
	<5% 2,6-DNT

2,6-Dinitrotoluene

PEL (OSHA)	: 1.5 mg/m ³ , 8 Hr. TWA, Skin
TLV (ACGIH)	: 0.15 mg/m ³ , 8 Hr. TWA, A2, Skin
AEL * (Du Pont)	: None Established

* AEL is Du Pont's Acceptable Exposure Limit. Where
governmentally imposed occupational exposure limits which are
lower than the AEL are in effect, such limits shall take
precedence.

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Material Safety Data Sheet

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PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Vapor Pressure	: <1 mm/Hg @ 100 C (212 F)
Vapor Density	: 6.3 (Air = 1)
Evaporation Rate	: <1 0
Solubility in Water	: <1 WT% @ 22 C (72 F)
Odor	: Distinctive Nitro Aromat.
Form	: Solid/Molten
Color	: Medium Yellow
Specific Gravity	: 1.32 @ 57C .

pH Information: Not available

Appearance: Crystalline/Clear Oil

Boiling Point, 760 mmHg: Starts decomposing at 250 C (482 F)

Freezing Point: 56 C (133 F) dry basis

STABILITY AND REACTIVITY

Incompatibility with Other Materials

Incompatible with strong oxidizers and caustics.

Polymerization

Polymerization will not occur.

Other Hazards

Instability: Unstable above 250 C (482 F). Will explode if confined and heated above 270 C (518 F).

Decomposition: May release hazardous Nitrogen Oxide (Nox) gases. Solid DNT is more sensitive to decomposition than liquid DNT. Contamination by foreign material, especially gritty substances, may considerably lower the decomposition temperature and increase the sensitivity of DNT to decomposition and explosion.

TOXICOLOGICAL INFORMATION

No Information Available

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Material Safety Data Sheet

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ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity

The product is moderately toxic (96-hr LC50 = 1 - 50 mg/l).

DISPOSAL CONSIDERATIONS

Waste Disposal

Comply with Federal, State, and local regulations. If approved, may be incinerated using special techniques, or removed to hazardous material landfill licensed for carcinogenic materials.

TRANSPORTATION INFORMATION

Shipping Information

DOT
Proper Shipping Name : Dinitrotoluene, Solid; Dinitrotoluene, Molten
Hazard Class : ORM-E

I.D. No. (UN/NA) : Solid = 2038; Molten = 1600

DOT/IMO

Proper Shipping Name : Dinitrotoluenes, Solid; Dinitrotoluenes, Molten

Hazard Class : Poison B, 6.1

UN No. : Solid = 2038; Molten = 1600

DOT/IMO Label : Poison

Special Information : Flash Point: 173 C

Packing Group : II

Reportable Quantity : 1000 lb

Shipping Containers

T/cars, T/trucks, steel drums

Shipping Information -- Canada

TDG

Proper Shipping Name : DINITROTOLUENE SOLID

PIN No. : UN 2038

TDG Class : 6.1 (9.2)

TDG Packing Group : II

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Material Safety Data Sheet

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Reported/Included.

Canadian Regulations

CLASS D Division 1 Subdivision B - Toxic Material/Acute Lethality.

CLASS D Division 2 Subdivision A - Very Toxic Material.
Carcinogen, Reproductive Toxin.

CLASS D Division 2 Subdivision B - Toxic Material. Skin or Eye
Irritant, Skin Sensitizer.

OTHER INFORMATION

NFPA, NPCA-HMIS

NPCA-HMIS Rating

Health : 2

Flammability : 1

Reactivity : 1

Personal Protection rating to be supplied by user depending on use conditions.

Additional Information

For further information, see "Dinitrotoluene Mixture"
Data Sheet.

Title III Classifications:

Acute Health	-	Yes
Chronic Health	-	Yes
Fire Hazard	-	No
Reactivity	-	Yes
Pressure	-	Yes

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : CHEMICALS & PIGMENTS
Address : MISSISSAUGA, ONTARIO
Telephone : 416-821-3300

Indicates updated section.

End of MSDS

* * * * *
M S D S
* * * * *
Canadian Centre for Occupational Health and Safety
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*** IDENTIFICATION ***

MSDS RECORD NUMBER : 691088
PRODUCT NAME(S) : Sodium Nitrite Solution
PRODUCT IDENTIFICATION : MSDS NUMBER: CED00191
DATE OF MSDS : 1993-10-28

*** MANUFACTURER INFORMATION ***

MANUFACTURER : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** SUPPLIER/DISTRIBUTOR INFORMATION ***

SUPPLIER/DISTRIBUTOR : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** MATERIAL SAFETY DATA ***

DuPont
Material Safety Data Sheet

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Sodium Nitrite Solution
CED00191 Revised 28-OCT-1993 Printed 3-FEB-1994

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

Corporate MSDS Number : DU002807
Formula : NaNO_2 (in water)
CAS Name : NITROUS ACID, SODIUM SALT
Grade : TECHNICAL; OXIDIZING SALT SOLUTION

Company Identification

MANUFACTURER/DISTRIBUTOR
DuPont Canada, Inc.

P.O. BOX 2200
STREETSVILLE
MISSISSAUGA, ONTARIO L5M 2H3

PHONE NUMBERS

Product Information : 1-800-387-2122
Transport Emergency : 1-613-348-3616 (24 HOURS)
Medical Emergency : 1-613-348-3616 (24 HOURS)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
TECHNICAL GRADE:		
SODIUM NITRITE	7632-00-0	41
WATER	7732-18-5	59
OXIDIZING SALT SOLUTION:		
SODIUM NITRITE	7632-00-0	40
SODIUM CARBONATE	497-19-8	2
SODIUM NITRATE	7631-99-4	10
WATER	7732-18-5	48

DSL: REPORTED/INCLUDED

HAZARDS IDENTIFICATION

Potential Health Effects

Harmful or fatal if swallowed. Harmful if inhaled.
Overexposure by inhalation or ingestion may cause reduced
oxygen carrying capacity of blood. Causes skin and eye
irritation.

HUMAN HEALTH EFFECTS:

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(HAZARDS IDENTIFICATION - Continued)

Human health effects of overexposure to the product by skin or eye contact may include skin irritation with discomfort or rash; or eye irritation with discomfort, tearing, or blurring of vision. Sodium nitrite has been infrequently associated with skin sensitization in humans. By inhalation, irritation of the upper respiratory passages with coughing may occur. By inhalation or ingestion, the effects may include low blood pressure with headache and fainting, or nonspecific discomfort such as nausea or weakness. Overexposure may also cause methemoglobinemia (reduced oxygen carrying capacity of the blood) with cyanosis (bluish discoloration of the skin), possibly progressing to dizziness, incoordination, shortness of breath, increased pulse rate, and loss of consciousness.

Sodium nitrite can also react with certain amines forming compounds which may cause cancer, mutations, or other toxicity. These compounds, known as nitrosamines, can be formed in acidic environments such as that found in the stomach. Since many medications and chemicals contain an amine group, simultaneous exposure to nitrites should be avoided.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing. Call a physician. Wash clothing before reuse.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

If swallowed, immediately give two glasses of water and induce vomiting. Call a physician. Never give anything by mouth to an unconscious person.

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Material Safety Data Sheet

(FIRST AID MEASURES - Continued)

Notes to Physicians

Absorption of this product into the body leads to the formation of methemoglobin which, in sufficient concentration, causes cyanosis. Since reversion of methemoglobin to hemoglobin occurs spontaneously after termination of exposure, moderate degrees of cyanosis need to be treated only by supportive measures such as bed rest and oxygen inhalation. Thorough cleansing of the entire contaminated area of the body including scalp and nails is of utmost importance. Cyanocobalamin (Vitamin B-12), 1 mg intramuscularly, will speed recovery. Intravenous fluids and blood transfusions may be indicated in very severe exposures.

FIRE FIGHTING MEASURES

Flammable Properties

Autodecomposition : 490 C (914 F) after drydown

Will not burn.

Fire and Explosion Hazards:

Strong oxidizer when water is removed. Combustible materials may catch fire more easily after being wet with sodium nitrite and dried. Product intensifies combustion of other materials. Fires are difficult to extinguish. See "Decomposition".

Extinguishing Media

As appropriate for combustibles in area.

Fire Fighting Instructions

Flood with water.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

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(ACCIDENTAL RELEASE MEASURES - Continued)

Accidental Release Measures

Flush spill area with plenty of water. Comply with Federal, State, and local regulations on reporting releases. The Superfund reportable discharge for sodium nitrite is 100 lbs.

HANDLING AND STORAGE

Handling (Personnel)

Do not take internally. Keep from contact with clothing and other combustible materials. Avoid contact with eyes and skin. Avoid breathing vapors or mist. Avoid breathing dust from dried-down product. Wash thoroughly after handling.

Storage

Do not store with acids, ammonium salts, cyanides, amines or reducing agents.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Good general ventilation should be provided to minimize contact with vapors, or dust from dried-down product.

Personal Protective Equipment

Eye/Face : Coverall chemical splash goggles.
Protective Gloves : Rubber gloves.

If product is allowed to dry and dusty conditions exist, use NIOSH/MSHA approved respiratory protection.

Exposure Guidelines

Applicable Exposure Limits

SODIUM NITRITE
PEL (OSHA) : None Established
TLV (ACGIH) : None Established
AEL * (Du Pont) : 2 mg/m³, 8 Hr. TWA, respirable dust
WEEL (AIHA) : None Established

SODIUM NITRITE
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(Continued)

PEL (OSHA) : None Established
TLV (ACGIH) : None Established
AEL * (Du Pont) : 2 mg/m³, 8 Hr. TWA, respirable dust
WEEL (AIHA) : None Established

SODIUM CARBONATE
PEL (OSHA) : None Established
TLV (ACGIH) : None Established
AEL * (Du Pont) : 5 mg/m³, 8 Hr. TWA

* AEL is Du Pont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Solubility in Water : 100 WT% Technical and Oxidizing Salt Solution
Odor : Odorless
Form : Clear liquid

	Technical	Oxidizing Salt
		Solution
Color	Pale Yellow	Straw Colored
Boiling Pt., 760 mmHg	115 deg C (239 deg F)	114.5 deg C (238 deg F)
Freezing Point	-1 deg C (30 deg F)	~10-20 deg C (50-68 deg F)
Specific Gravity	1.32 at 16 deg C (60 deg F)	~1.4/16 deg C (34/60 deg F)
Vapor Pressure at		
25 deg C	17 mmHg	~50 mmHg
38 deg C	35 mmHg	~90 mmHg
Vapor Density (Air=1)	Less than 1	Less than 1
pH Information	8.9	9
Evaporation Rate	Greater than 1	Greater than 1

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STABILITY AND REACTIVITY

Chemical Stability

Unstable with heat after dry down.

Decomposition

Decomposes with heat.

Decomposition temperature is 490 deg C (914 deg F) after drydown to produce oxygen and toxic nitrogen gases.

Polymerization

Polymerization will not occur.

Other Hazards

Incompatibility : Incompatible with acids, ammonium salts, amines, activated carbon, cyanides, and reducing agents. May react with secondary or tertiary amines to form nitrosamines (Certain nitrosamines are cancer-suspect agents.).

TOXICOLOGICAL INFORMATION

No Information Available

ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity

96-hour LC50, minnows: >100 mg/L

DISPOSAL CONSIDERATIONS

Waste Disposal

Comply with Federal, State, and local regulations. If approved, flush to waste treatment system.

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TRANSPORTATION INFORMATION

Shipping Information

DOT

Proper Shipping Name : Hazardous Substance, Liquid, N.O.S.*
Hazard Class : ORM-E
I.D. No. (UN/NA) : NA No: 9188
DOT Label(s) : None
Special Information : *Not regulated in packages containing less than 300 lbs.
DOT Placard : None

DOT/IMO

Proper Shipping Name : Not regulated as a hazardous material.
Hazard Class : Not regulated.

Reportable Quantity : 100 lb

Shipping Containers

T/C, T/T, sample bottles

Shipping Information -- Canada

TDS

Proper Shipping Name : OXIDIZING SUBSTANCES N.O.S. LIQUID
(SODIUM NITRITE, SODIUM NITRATE, SODIUM CARBONATE)
FIN No. : UN 1479
TDS Class : 5.1, (9.2)
TDS Packing Group : II

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Reported/Included.

Canadian Regulations

CLASS C Oxidizing Material

CLASS D Division 1 Subdivision B - Toxic Material/Acute Lethality.

CLASS D Division 2 Subdivision B - Toxic Material. Skin or Eye Irritant.

(NFC0019)

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OTHER INFORMATION

Additional Information

Title III Classifications:

Acute Health - Yes
Chronic Health - Yes
Fire Hazard - No
Reactivity - No
Pressure - No

For further information, see Du Pont's "Sodium Nitrite" Data Sheet.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : CHEMICALS & PIGMENTS
Address : MISSISSAUGA, ONTARIO
Telephone : 416-821-3300

Indicates updated section.

End of MSDS

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 756024
PRODUCT NAME(S) : SODIUM NITRATE
PRODUCT IDENTIFICATION : 06SDNA
DATE OF MSDS : 1994-06-09

*** MANUFACTURER INFORMATION ***

MANUFACTURER : GRACE DEARBORN INC
ADDRESS : 3451 ERINDALE STATION ROAD
MISSISSAUGA ONTARIO
CANADA L5C 2S9
EMERGENCY TELEPHONE NO. : 905-279-2222 (OFFICE HOURS)
613-996-6666 (AFTER HOURS)

*** MATERIAL SAFETY DATA ***

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MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

=====

1) PRODUCT IDENTIFICATION: SODIUM NITRATE

PRODUCT USE: COMMODITY CHEMICAL

MANUFACTURER:
GRACE DEARBORN INC.
3451 ERINDALE STATION ROAD
MISSISSAUGA, ONTARIO
L5C 2S9

EMERGENCY PHONE:
OFFICE HOURS: 905-279-2222
AFTER HOURS: 613-996-6666

TRANSPORTATION OF DANGEROUS GOODS CLASSIFICATION:
SODIUM NITRATE 5.1 UN1498 III
WHMIS CLASSIFICATION:
CLASS C: CLASS D DIVISION 2 SUBDIVISION B

=====

2) INGREDIENTS:

Chemical Name.	CAS #	TLV(mg/m3)	LD50(mg/Kg)
SODIUM NITRATE	7631-99-4	N/E	2000C
%RANGE-(60.0- 100.0)			

=====

3) PHYSICAL DATA:

Physical state.....	SOLID	Freezing point.(Deg.C)	N/A
Odour threshold.....	N/D	Boiling point..(Deg.C)	N/A
Specific gravity.....	1.28	Vapour pressure.....	N/A
Density.....	N/D	Vapour density(air=1).	N/A
pH.....	1% = 7 - 8	Evaporation rate.....	N/A
Solubility in water..	73	Coeff. of water/oil...	N/D
Appearance and odour..			

WHITE PELLETS, ODOURLESS

4) FIRE AND EXPLOSION HAZARD DATA:

CONDITIONS OF FLAMMABILITY:

NON-FLAMMABLE

EXTINGUISHING MEDIA:

WATER X

FOAM X

CO2 X

Other : DRY CHEMICAL

SPECIAL PROCEDURES:

TREAT AS A CLASS A FIRE.

MODERATE WHEN MIXED WITH ORGANIC MATTER - EXPLODES WHEN
HEATED OVER 1000 DEGREES C - OXIDIZING AGENTS.

FLASH POINT: (Deg. C FMCC) NONE

FLAMMABLE LIMITS IN AIR % BY VOLUME: LOWER N/D

UPPER N/D

AUTO IGNITION TEMP: (Deg. C) N/D

HAZARDOUS COMBUSTION PRODUCTS: N/D

EXPLOSION DATA:

SENSITIVITY TO IMPACT..... :NONE KNOWN

SENSITIVITY TO STATIC DISCHARGES..:NONE KNOWN

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MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

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5) REACTIVITY DATA:

STABILITY (NORMAL COND.) STABLE X UNSTABLE

CONDITIONS TO AVOID:

AVOID EXTREME HEAT ABOVE 1000 DEGREES C

CONDITIONS OF REACTIVITY:

N/D

INCOMPATIBILITY: (MATERIALS TO AVOID)

ORGANIC MATERIALS

HAZARDOUS DECOMPOSITION PRODUCTS:

N/D

6) TOXICOLOGICAL PROPERTIES:

ROUTE OF ENTRY: SKIN CONTACT X ABSORBED BY SKIN EYE CONTACT X

INHALATION X INGESTION X

EFFECTS OF ACUTE EXPOSURE

MAY CAUSE IRRITATION TO SKIN AND EYES. AVOID PROLONGED AND/
OR REPEATED CONTACT.

MAY CAUSE DISCOMFORT, NAUSEA OR VOMITING IF INGESTED.

MAY CAUSE IRRITATION TO UPPER RESPIRATORY TRACT IF INHALED.

EFFECTS OF CHRONIC EXPOSURE:

N/D

Oral rat LD50mg/Kg.(calc.):>2000

Exposure limits..... :N/D

Irritancy..... :N/D

Sensitization.....:N/D

Synergistic Mat..... :NONE KNOWN

Carcinogenicity..... :NONE KNOWN

Reproductive Eff..... :NONE KNOWN

Teratogenicity..... :NONE KNOWN

Mutagenicity..... :NONE KNOWN

=====

7) PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT:

EYE PROTECTION:X

GLOVES:X

CLOTHING:X

RESPIRATORY PROTECTION:

DUST MASK

VENTILATION REQUIREMENTS:

MECHANICAL (GENERAL)

SPILL AND LEAK PROCEDURES:

PICK UP DRY SPILLS AND RETURN TO CONTAINER. FLUSH

REMAINDER TO DRAIN WITH EXCESS WATER.

WASTE DISPOSAL:

USE AN APPROVED SCAVENGER SERVICE.

HANDLING PROCEDURES:

WEAR CHEMICAL GOGGLES AND RUBBER GLOVES.

USE PERSONAL PROTECTIVE CLOTHING:

STORAGE REQUIREMENTS:

STORE AWAY FROM ORGANICS IN DRY FIREPROOF BINS.

WOOD AND PAPER BAGS SATURATED WITH SODIUM NITRATE SHOULD
BE REMOVED FROM PREMISES.

SPECIAL HANDLING INFORMATION:

NONE

=====

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MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

=====

8) FIRST AID MEASURES:

WASH CONTAMINATED AREA THOROUGHLY WITH SOAP AND WATER. LAUNDER CLOTHING
BEFORE REUSE. FLUSH EYES WITH FLOWING WATER FOR 15 MINUTES AND GET MEDICAL
ATTENTION. IF INGESTED, INDUCE VOMITING AND GIVE LARGE QUANTITIES OF
WATER AND GET MEDICAL ATTENTION IMMEDIATELY.

GASTRIC LAVAGE MAY BE REQUIRED.

=====

9) OTHER INFORMATION:

NONE

=====

10) PREPARATION INFORMATION

PREPARED BY: T.R.Erwin.

GRACE DEARBORN INC.

P.O. BOX 3060 STATION A.

MISSISSAUGA ONTARIO, L5A 3T5

DATE PREP./REV. 1994.06.01

PRINT DATE: 1994.06.09

PHONE: 905-279-2222

FAX: 905-279-0020

N/D-No Data N/A-Not Applicable N/E-Not Established <-Less >-Greater

A=Oral rat LD50 B=Oral rat LD low C=oral LD50/LD low other animal

D=Estimated 1000 E=Arbitrary 2000 F=Other Route Prefix C=Ceiling limit

=====

SECTION 12.0.
SAMPLING PLAN

12.0. SAMPLING PLAN

12.1. INTRODUCTION

This section describes the general process liquid and gas sampling procedures to be used including: the analytical parameters, typical locations and methods. The sampling and monitoring procedures described in this section have been selected to determine the properties and compositions of the feed stream, oxidized effluent stream and the off gases, thereby demonstrating the performance of the Wet Air Oxidation system.

12.2. SAMPLING EQUIPMENT, PROCEDURES AND LOCATIONS

The sampling equipment, procedures and locations are summarized in Table 12 -1. Figure 12-1 shows the incoming red water sampled at point 1; diluted red water sampled at point 2; oxidized effluent sampled at point 3 and offgases sampled at point 4. No sampling points were provided within the reactor system to minimize safety hazards associated with the cooling and pressure let down of hot samples.

12.3. ANALYTICAL PROCEDURES

The analyses planned for the samples are listed in Table 12 - 2.

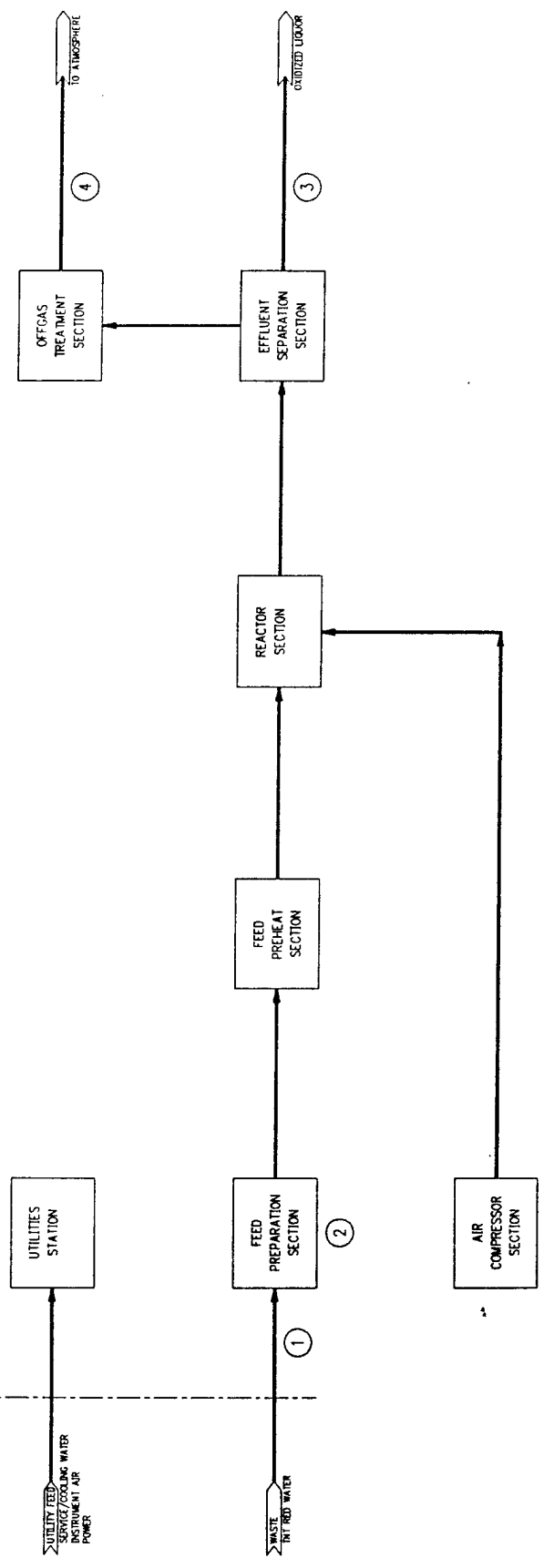
12.4. OPERATIONAL PARAMETERS

The operational parameters to be monitored by the DCS system include:

- pH of diluted red water to reactor system
- Level in feed drum
- Differential pressure across duplex strainer
- Flow of raw red water
- Flow of effluent recycle stream
- Flow of diluted red water to reactor system
- Temperature of feed at the tubeside outlet of the feed/effluent exchanger
- Temperature and pressure on the outlet line of the reactor system
- Temperature of oxidized effluent at the outlet of the feed/effluent exchanger
- Temperature of oxidized effluent at the outlet of the water cooler
- Level in high pressure separator
- Level in low pressure separator
- Pressure on vapour line of high pressure separator
- Pressure on vapour line of low pressure separator

- Temperature of oxidized waste water in effluent drum
- Level in effluent drum
- Air flows to the reactor system
- Air flow to the inlet of the feed/effluent exchanger
- Oxygen content in the offgas line
- Total offgas flow rate

BATTERY UNIT
CLIENT KENOX



KENOX CORPORATION		BLOCK FLOW DIAGRAM		SAMPLING LOCATIONS		USAEC RED WATER TREATMENT TECHNOLOGY		TEST PLAN AND SITE PREPARATION PROJECT	
Designed by	D. BULL	Checked by	T. LEE	Drawn by	W.C. / 1984	Revised	DATE	Project No.	941014
Issued by	KENOX	Approved by	W.C.	Reviewed by	W.C.	Project No.	941014-SP-140	Rev.	0
SEC. 7		CONFIDENTIAL DESIGN		KENOX CORPORATION		KENOX CORPORATION		KENOX CORPORATION	
1000		1000		1000		1000		1000	
200		200		200		200		200	

Table 12 -1 : Sample Collection Locations and Equipment

Fig. 12-1 Loc'n	Description	Access	Equipment	General Procedure
1	Raw Red Water	Tap	Glass Bottle	Hourly Grab Sample
2	Diluted Red Water	Tap	Glass Bottle	Hourly Grab Sample
3	Oxidized Effluent	Tap	Glass Bottle	Hourly Grab Sample
4	Offgases	Port	Bag Sample	Hourly Grab Sample

Table 12 - 2 : Summary of Analytical Requirements and Methods

SAMPLE	ANALYSIS	METHOD
Raw Red Water/ Diluted Red Water/ Oxidized Effluent	pH	SM No. 4500-H ⁺
	COD	SM No. 5220 "D"
	TOC	SM No. 5310 "B"
	Total Volatile Solids	SM No. 2540
	Total Solids	SM No. 2540
	Chlorides	ASTM D4327-91
	DNT sulfonates	Gas Chromatography
	alpha - TNT	Gas Chromatography
	2,4 DNT	Gas Chromatography
	2,6 DNT	Gas Chromatography
	1,3,5 TNB	Gas Chromatography
	1,3 DNB	Gas Chromatography
	Nitrite	SM No. 4500 - NO ₂
	Nitrate	SM No. 4500 - NO ₃
	Sulfate	ASTM D4327-91
Offgases	CO	Gas Chromatography
	CO ₂	Gas Chromatography
	NO	Infrared Spectrophotometry
	NO ₂	Electrochemical Sensor
	N ₂	Gas Chromatography
	NH ₃	Infrared Spectrophotometry
	O ₂	Gas Chromatography
	SO ₂	Infrared Spectrophotometry

"ASTM" refers to Annual Book of ASTM Standards, Water and Environmental Technology, Section II, American Society for Testing and Materials.

"SM" refers to Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992.

SECTION 13.0.
OPERATIONS MANUAL

13.0. OPERATIONS MANUAL

13.1. GENERAL DESCRIPTION

13.1.1 MANUAL PURPOSE

This manual provides instructions for the operations and maintenance of the red water WAO pilot plant.

13.1.2 SYSTEM DESCRIPTION

This section discusses the objectives, process equipment and process flow of the treatment system for red water. The pilot plant consists of the following processes :

- Kenox Wet Air Oxidation (WAO) system
- Utility systems.

KENOX WAO System

The operating flow rate of the WAO system which is comprised of red water and recycled effluent is 3 USGPM. Refer to Process Flow Diagram (PFD) in Section 3 for the following flow description.

Incoming TNT red water from the local storage tank is delivered to the Kenox feed drum D-104 via a dual strainer and the waste feed pump P-101. An excess differential pressure reading from local PDI-301 indicates the basket is plugged. The flow should be directed to the other basket and the plugged screen should be removed and replaced by a clean screen.

At the inlet of feed drum D-104, the TNT red water is blended with a treated effluent stream from the final effluent pump P-105 at a ratio that has been preset in the flow ratio controller, FFRC-401. The diluted feed is pumped from the feed drum by high pressure feed pump, P-103 to the tubeside of the feed/effluent exchanger E-101. In this exchanger, the feed stream temperature is heated to the required reactor inlet temperature by the reactors' effluents.

The Kenox reactor system comprises of reactors connected in series. Compressed air is injected into the reactors to supply the required oxygen for the reaction.

The combined oxidized liquid and spent air is withdrawn from the reactors and cooled to 104 °F via E-101 and the water cooler E-103. Gases and oxidized waste water leave the cooler E-103 and proceed to a two stage pressure let down and separation system, D-101 and D-102.

The off-gas, which at this point is mainly carbon dioxide , nitrogen and water vapor is vented to the atmosphere. Part of the oxidized waste water is recycled back via the effluent recycle pump, P-105 to the inlet of the feed drum, D-104 and the other portion is discharged.

Compressed air is supplied to the Kenox reactors by the reciprocating compressor C-101. Compressed air leaving the compressor flows to the air accumulator D-103 before entering the Kenox reactors. The total air flow to the Kenox reactors is controlled by an oxygen analyzer which measures the O₂ content of the off gas leaving the system.

UTILITY SYSTEMS

Instrument air is assumed to be available on site.

Cooling water is assumed to be available on site. The cooling water supply/return system is shown in Dwg. No. 941014-FD-105.

13.1.3 KEY OPERATING PARAMETERS

The primary control for any Wet Air Oxidation system including "Kenox" is

- Feed Rate
- Oxygen Flow (Air Demand)
- Pressure in Reactors
- Reaction Temperature

Feed Rate

The feed to the Kenox System is limited by the size of the reactors and by the COD level to a lesser extent as there is a correlation between the flow rate and residence time.

Oxygen Flow

Excess oxygen is analyzed by AT-501 (Dwg. No. 941014-FD-104) located on the gas line releasing to the vent stack. Test runs will determine the optimum air supply requirements to the reactors.

Reactor Pressure

The pressure must be set so as to prevent boil-off and maintain a liquid phase in the reactors. The reaction enthalpy is used for heating up the liquid and oxygen containing gas feeds to the reaction temperature, evaporation of water up to the vapour-liquid equilibrium and compensation for heat losses from the reactors. This pressure is maintained by PCV-312 located on the vapor exit from separator D-101.

Reaction Temperature

The temperature is the most important process variable in the WAO process as it determines the rate of the oxidation reaction. The required temperature is determined by the chemical composition of the waste water and the desired conversion efficiency. For low COD heat must be added via the electric heater.

13.2. START-UP PROCEDURE

13.2.1 START UP COOLING WATER SYSTEM

- Open valve on the 2" main cooling water line to the pilot plant.
- Open cooling water supply and cooling water return isolation valves to the following equipment:
 1. Air compressor, C-101
 2. Reactor Effluent Cooler, E-103
 3. Reactor System

13.2.2 ACTIVATE INSTRUMENT AIR SYSTEM

- Open all air supply valves to pneumatic instruments.
- Start up instrument air system. Check if pressure setting on valve PRV-XXX on the instrument air line is at 90 psig.

13.2.3 SYSTEM WATER FILL

- Activate process control system.
- Open suction and discharge valves around high pressure feed pump, P-103.
- Open all manual in-line process valves around the following equipment: E-101, E-102, reactor system, E-103, D-101, D-102 and inlet to D-105.
- Open service water supply isolation valves and XCV-602 by-pass valve to allow water flow to suction of P-103.
- Set reactor pressure controller, PIC-312 on the reactors to 590 psig.
- Start pump P-103. Adjust the variable speed drive to maintain a flow of 4 USGPM as indicated by FT-404.
- The following equipment will fill with water:
 - a) Tube side of exchanger E-101
 - b) Reactors
 - c) Shell side of exchanger E-101
 - d) Tube side of E-103
 - e) H.P. Separator, D-101

- After D-101 fills to the 50 % level, open control valve, LCV-108, manually to allow water flow to L.P. Separator, D-102. Maintain 50 % level in D-101.
- Fill L.P. Separator, D-102 to the 50 % level and open LCV-110 manually to allow flow to D-105. Maintain 50 % level in D-102. **Caution:** do not overfill D-102. Oxygen analyzer AT-501 must not be in contact with water.
- Allow D-105 to fill to 50% level.
- Open discharge valve at the outlet of D-105 , suction and discharge valves around effluent recycle pump, P-105 and valve to allow water to leave the system.
- Start pump, P-105.

13.2.4 INCREASE SYSTEM TEMPERATURE

- Adjust P-103 VSD to maintain a flow rate of 3 USGPM.
- Set temperature controller TIC-202 to 484 °F.
- Refer to electric heater, E-102, start-up procedure in the vendor's manual and start heater.
- Reactor system temperature, TI-209 should stabilize at 484 deg F.

13.2.5 PRESSURIZE SYSTEM

- Once the reactor temperature reaches 484 deg F , the system pressure, PI-312, will be approximately 590 psig.
- Open all manual in-line valves between the air compressor and the reactor system.
- Refer to compressor start-up procedure in vendor's manual.
- Start air compressor C-101.
- Oxygen analyzer controller AIC-501 should be set on override to allow full air flow into the reactor system.
- Set air flow controller FIC-407 at 232 lbs/hr and air flow ratio controller FFIC-408 to proportion the second air flow in the range of 50% of the total air flow. (FIC-407/408 to be operated manually).

- Increase the pressure set point on pressure controller, PCV-312 in increments of 100 psig until the system stabilizes at 985 psig.
- Check system for leaks while raising pressure. It is expected that the reactor temperature will drop slightly when air is first admitted to the reactors.
- System stabilized at 985 psig - check discharge pressure on the high pressure feed pump; pressure gauge PI-307 should read 1035 psig plus.
- Check all level instruments for appropriate settings.

13.2.6 INTRODUCTION OF WASTE WATER FEED STREAM

Once the reactor system stabilizes at 484 °F:

- Set the flow ratio control FFRC-401 such that flows of effluent recycle stream and feed waste meet the dilution factor.
- Open all manual valves on discharge of P-105 to allow recycle stream to flow to D-104.
- Start waste feed pump, P-101. Check PI-303 for discharge pressure. Reading should be approximately 30 psig.
- Observe FI-401 and FI-402, the flow ratio should agree with the dilution factor as set by FFRC-401.
- Allow D-104 to fill to 50 % level.
- Open manual discharge valve on D-104.
- Set oxygen analyzer, AT-501 at 5 % excess O₂.
- Close all service water valves leading to the suction of P-103.
- Change air flow ratio controller FFIC-408 from manual to automatic mode (i.e. flow of air now on AIC-501 control).
- Optimize as necessary feed flow rate, FIC-407, FIC-408 and TI-209 to maintain temperature around 484 °F.
- Monitor reactor inlet temperature of waste water stream, TI-202 and reactor outlet temperature, TI - 209.

- Take a sample of the oxidized waste water periodically and have it analyzed for COD concentration and pH.

13.3. SHUTDOWN PROCEDURE

For a planned shutdown, waste water from the feed tank and partially oxidized waste water remaining in the system will be processed. After the processing of the waste, the system will be completely flushed so that all contaminated piping components are thoroughly cleaned and free of TNT red water.

The level of waste water in the feed drum will be decreased to the minimum operating level before commencing with the shutdown procedures. This will shorten the shutdown duration as well as save energy costs associated with operating the electric heater, E-102.

- Open service water isolation valve to waste water feed line no. 101. Close waste water feed valve to stop the flow of raw waste into drum D-104. This will allow service water to flush the incoming feed line.
- Adjust flow ratio controller FFIC-401 to allow 100 percent flow from P-101 and no flow of the effluent recycle stream.

This can be considered as time, $T = 0$ hr. (i.e. no contaminated liquid is being fed to D-104). Assuming the flow rate is 3 USGPM and D-104 is full, the approximate shutdown time is equal to 4 hours (i.e. 1.5 hours system liquid retention plus 2.5 hours D-104 volume).

As the feed from D-104 becomes increasingly dilute and the demand for COD decreases, the requirement for air will diminish and system temperatures will start to fall. As a result, air flow control valves FCV-407/8 will automatically close responding to the high oxygen level measured from the oxygen analyzer.

- Shutdown air compressor C-101 (refer to compressor operating manual). Control valves XCV-604/5 will close automatically cutting off the supply of air to the reactor system.
- Set temperature controller TIC-202 to 20 °C. Electric heater, E-102 will automatically return to 'Stand by' mode. All system temperatures will gradually fall.
- Decrease the set point of pressure controller PIC-312 in increments of 100 psi to slowly 'walk' the system pressure down.

At time $T = 4$ hours or later, adjust flow ratio controller FFIC-401 to allow rinse water discharged from P-105 to flush the effluent recycle line into D-104. After a few minutes reset FFIC-401 to 100 % flow from P-101.

- Shutdown P-101.
- When the water in D-104 has reached the desired level shutdown P-103. The water remaining in D-104 can be used to dilute the next batch of raw waste.
- Shutdown P-105. The water left in the system can remain there until the next start-up. If maintenance is required, vent, drain and/or isolate as required.